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THE WHITE STAR LINE STEAMSHIP "CELTIC."

Three and one-half months after the *Celtic*, the greatest steamship afloat, was launched from the shipyard of Harland and Wolff, of Belfast, Ireland, she started on her maiden voyage across the Atlantic. Her departure from Liverpool brought throngs of people down to the landing stage to see her off. No storms were encountered on the passage, and the course of 2,890 miles was covered in eight days, forty-six minutes.

A description of the *Celtic* was given in MARINE ENGINEERING of May, 1901, but it may be well to repeat the principal dimensions, which are: Length over all, 700 feet; beam, 75 feet; depth, 49 feet. Though four feet shorter than the *Oceanic*, the *Celtic* is in all other respects larger than that vessel, being seven feet wider and five feet deeper. She can carry 18,000 tons of cargo, and her displacement at load draft is 38,220 tons.

In constructing this ship, the idea has been that comfort and safety should always come first in the question of design and that speed was secondary. All the first-class rooms are amidships, and most of them are of larger size than those on other Atlantic liners. An innovation in the first-class accommodations is that of single rooms for passengers traveling alone. The third-class passengers are given very comfortable accommodations. There is a large social hall, a smoking-room, a dining-room with seats for everybody, lavatories and bath-rooms. In all classes there are accommodations for 2,859 passengers, besides a crew of 335.

STEAMSHIP CELTIC LEAVING THE LANDING STAGE AT LIVERPOOL.

(Photographed for Marine Engineering by G. M. Roche, Dublin.)

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THEORETICAL INDICATOR AND VALVE DIAGRAMS AND THEIR RELATION TO MARINE ENGINE DESIGN.

BY THEODORE LUCAS.

For the design of a marine engine it is necessary to determine upon the indicated horse power required to drive the ship at the desired speed. The engine has to be proportioned large enough and strong enough to supply this power efficiently and economically.

According to the purpose of the ship, certain preliminary decisions as to type of engine and steam generator will have to be made. A certain initial steam pressure will have to be decided upon, corresponding to the type of steam generator chosen, which may be either water tube or Scotch, or locomotive or water-leg boilers. This initial steam pressure will usually settle the type of engine, which may be single, compound, triple or quadruple expansion.

Other points are whether a high or low piston speed is desired, or if long stroke or short stroke engines are considered preferable for the purpose of the ship.

The example given represents a short stroke high speed triple expansion engine of torpedo-boat type, with about 240 pounds absolute initial pressure.

For getting first a representation of the total indicated horse power, it is customary to refer the whole load to the low pressure cylinder in the form of a mean pressure per square inch of its sectional area. The value of this mean pressure depends upon the initial pressure and the final condenser pressure, as well as upon the total expansion through the different cylinders.

The appended table A shows the relation of the total expansion to the mean pressure expressed as a percentage of the initial pressure.

From this mean pressure can be settled the size of the low pressure cylinder which will realize the needed indicated horse power.

$$P_m = P \times k \left(\frac{1 + \log r}{r}\right)$$

P_m = Mean pressure.
P = Initial pressure.
r = Number of expansions.

$$\left(\frac{1 + \log r}{r}\right)$$

The coefficient k can be found from the Table A, where k has a value of 0.66 for triple expansion engines.

TABLE A.

r	Coefficient.	r	Coefficient.	r	Coefficient.
50.	0.066	6.25	0.302	2.22	0.540
25.	0.120	5.56	0.326	2.00	0.564
16.6	0.153	5.00	0.348	1.82	0 586
12.5	0.188	4.00	0.398	1.67	0.604
10.0	0.220	3.33	0.440	1.54	0.620
8.33	0.250	2.86	0.478	1.43	0.633
7 14	0.276	2.50	0.512	1.33	0.644

In the absence of a more exact knowledge of the law of expansion of steam in cylinders the common hyperbole is usually employed for purposes of investigation.

In Fig. 1 the outer line gives the maximum expression of power that could be realized, if the steam should be employed without losses in the low pressure cylinder. From the ratio of the total expansion the size of the individual cylinders and their cut-offs can be decided upon. An approximation to the clearance and receiver volumes can be made, the first being a certain percentage of the volume swept by the piston, while the latter depends upon the general arrangement and size of the intermediate piping and valve chests. The size of the high pressure cylinder will result naturally, first, from the total expansion.

The intermediate cylinders may be varied somewhat, according to the desire of having either an approximately equal division of the horse power between the cylinders, or an approximate equality between the

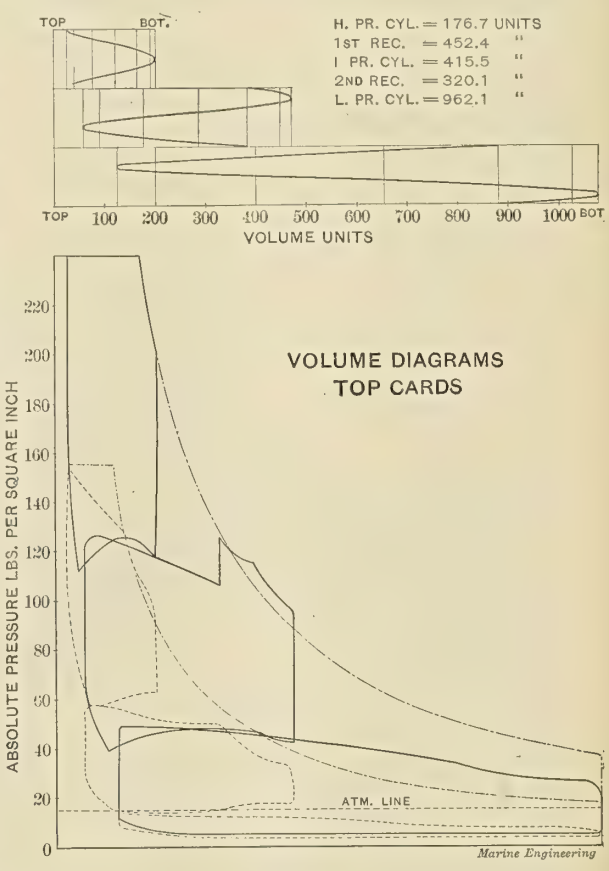

FIG. I.

maximum pressures that are delivered to the piston-rod, or an approximately equal temperature range in all cylinders, or a compromise between some or all of these special considerations.

For the determination of the distribution of the power between the cylinders, the volume diagram, Fig. 1, may be employed. At the top are given the relative volumes of cylinders, clearances and receiver spaces, while below are shown the corresponding pressures of the steam passing through the engine.

As a sufficiently close approximation the pressures are varied inversely proportional to the volumes.

For decision of desirable cut-offs, as well as the other steam distributing qualities of the valve, diagrams of different types like Zeuners, Müllers, Sweets,

Ellipse, etc., are successfully employed. These show, at a glance, the effect of different angles of advance, of different leads and of different steam and exhaust laps.

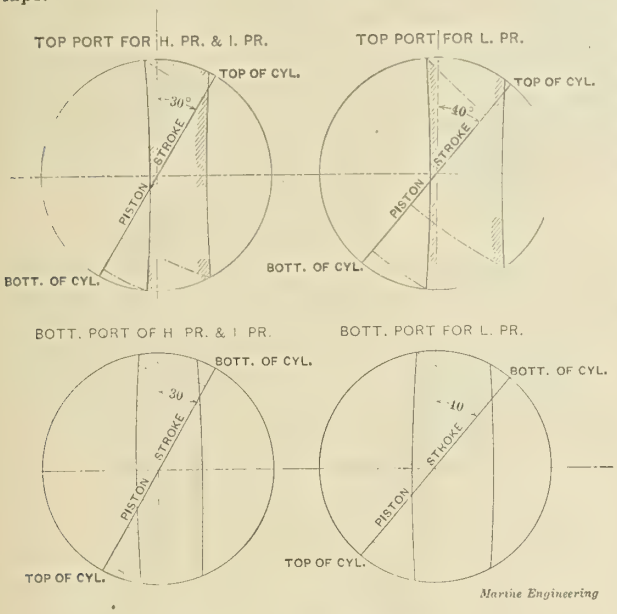

FIG. 2. VALVE DIAGRAMS.

The diagrams Fig. 2 are of the Müller type, which allows of rapid construction and an easy correction for the finite length of the connecting rod, as well as of the excentric rod.

TABLE B.

	H. P. & I. P.		L. P.	
	Top.	Bottom.	Top.	Bottom.
Steam Lap.....	⅞ in.	¾ in.	1⅛ in.	1 in.
Exhaust Lap.....	+⅛ in.	+⅜ in.	+⅛ in.	+⅜ in.
Lead.....	7-64 in.	19-64 in.	⅛ in.	5-16 in.
Angular Advance..	30°	30°	40°	40°
Cut-off.....	0.808	0.785	0.675	0.640
Compression.....	0.077	0.095	0.175	0.145
Exhaust Op.....	0.036	0.040	0.065	0 085
Width of Ports.....	1¾ in.	1¾ in.	1¾ in.	1¾ in.

Table B shows the results for the same high speed engine of torpedo boat type. With all the data of the valve gear influence, the volume diagram Fig. 1 can be constructed in the particular shape for each cylinder. A peculiar hump near the end of the stroke of the intermediate cylinder indicates a new inflow of steam and the raising of the receiver pressure through the opening of the exhaust port of the high pressure cylinder.

For comparison with this theoretical set of diagrams an actual set has been added, which was taken from the engines after construction.

Unfortunately the steam pressure could not be maintained, and the pressures are therefore much lower proportionately than in the theoretical diagram.

It will be seen, however, that the outlines of the two sets are very similar to each other, indicating a close realization of the anticipated result.

Marine engines have to be reversible and a mechanism has to be provided that allows the direction of the valve travel to be changed at will. This can be realized by different methods, of which some of the most frequent are: 1, Exchange of steam and exhaust ports by special reverse valves, as seen in a good many small auxiliary engines; 2, A single loose excentric, which can be unhooked from the valve connection, as seen in many of the slow speed, long stroke paddle wheel engines; 3, Link mechanism, of which manifold and often modified forms are seen in the modern multiple cylinder engine, notably those of Stephenson, Marshall, Heusinger, Joy, Brown, Fink, etc.

Fig. 3 shows the diagram of a Stephenson double-bar link, in which the center of the block-pin coincides

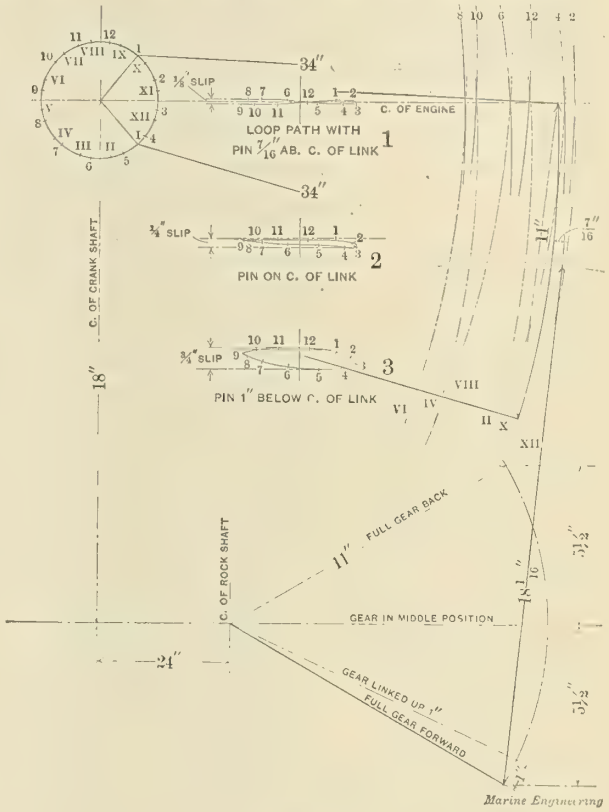

FIG. 3.

in the extreme positions with the center of the excentric rod pins. One of the practical points that may be of the greatest importance for efficient performance for the steam distribution is the slip of the link on the block.

It should, under all circumstances, be as small as possible, though, unfortunately, it cannot be altogether avoided with the usual practical execution of the link gears.

Large slip would produce heavy wear quite quickly on the comparatively limited bearing surfaces, particularly if heavy slide valves were driven at high speed and frequent reciprocations.

A small amount of play will affect the steam distribution quite perceptibly if it is considered that the laps and leads are varied by eighths and sixteenths of an inch.

The position of the hanger-pin on the link exercises great influence upon the magnitude of the slip, and for more complete understanding and determination of the best position of this hanger-pin the slip for three of its possible positions has been worked out, as shown in Fig. 3.

As seen, a position above the center of the link produces a loop path of the excentric pin with about equal halves, and by it the smallest lateral movement of less than one-eighth of an inch. As shown in Fig. 4, this position of the hanger-pin has the result of keeping the slip small for all the other positions of the link up to the extreme backing position.

The determination of these loop paths can be effected quite rapidly with the help of a link skeleton drawn on a piece of heavy tracing cloth, and their study will well repay the time and labor devoted to them.

The diagram should be executed to the largest convenient scale to insure the best possible accuracy.

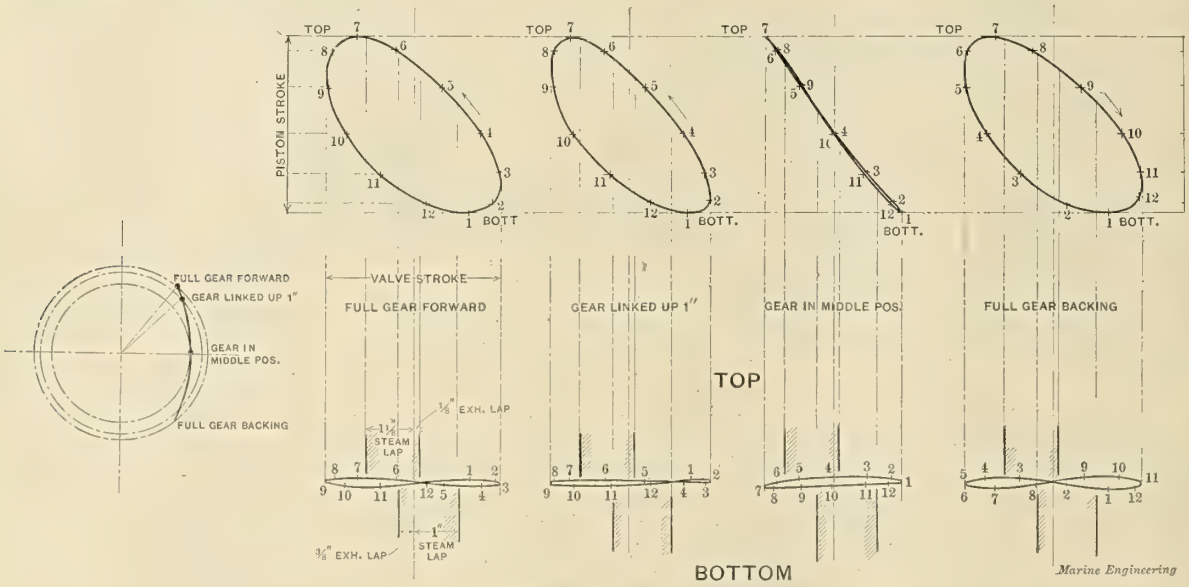

FIG. 4. VALVE AND BLOCK SLIP DIAGRAMS.

The points in the loop paths represent positions of the valve itself with elimination of the influence of the finite length of the excentric rods. It is possible therefore to develop valve diagrams from them, as shown in Fig. 4.

Through them an opportunity is given of investigating linked-up conditions with their consequent earlier cut-off and compression positions.

The diagrams shown in this case are of the valve ellipse type with the direction of the piston travel across the direction of the valve travel, being also corrected for the finite length of the connecting rod. The positions of cut-off, etc., can be used for the construction of volume diagrams in the same manner as the valve diagrams in Fig. 2.

It will readily be understood that different cylinders with different excentric angles will occasion a new set of loop paths, valve and volume diagrams.

The different linking-up positions can be represented by a single effective excentric pin which travels on a parabola from the extreme forward or backing position toward the middle position of the link with constantly decreasing radius.

From the several points gained, the parabola can be constructed with the possibility of investigating any intermediate position, rapidly and completely.

Diagrams present one of the best and surest means of finding the desirable compromise between quite a number of important considerations and deserve full attention from engine designers, not only because they settle rapidly and efficiently the case under consideration, but enable a valuable and very close judgment to be formed upon newly presented problems.

Ship Models at Glasgow, Scotland.—An exhibition of ship models is one of the most interesting exhibits of the Glasgow Exhibition. The models are of ships of the mercantile marine, and are arranged chronologically from the famous *Comet*, built in 1812, down to the modern transatlantic liner of today.

Torpedo Boat Viper Wrecked.—The British torpedo boat destroyer *Viper*, the first to be fitted with Parson's turbines, was wrecked on the rocks off the Island of Alderney, British Channel, on August 4th.

Speed of the Steamship Deutschland.—The average speed of the *Deutschland*, on the passage from New York to Plymouth, ending July 17th, was 23.51 knots, which is one-eighth of a knot faster than her best previous record.

Water Tube Boiler Trials.—A series of trials were recently conducted on the new Thornycroft-Marshall water tube boiler. No economizers were used. The coal burned was Welsh hand picked. Six eight-hour trials were made at different rates of combustion, from 12 to 30 pounds coal per square foot of grate surface, and the equivalent evaporation per pound coal ran from 11 pounds water at the former figure down to 9 pounds at the latter. The boiler has 32 1-2 square feet of grate surface and 1,200 square feet of heating surface.

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HAMBURG-AMERICAN LINE YACHT, PRINZESSEN VICTORIA LUISE, LEAVING NEW YORK.

TWIN SCREW PLEASURE YACHT PRINZESSEN VICTORIA LUISE.

A new type of commercial steamer was recently built for the Hamburg-American Line by the firm of Blohm & Voss, of Hamburg. She is named the *Prinzessen Victoria Luise*, and is intended solely for pleasure cruises and long excursions, being, in fact, as in outward appearance, a very large yacht.

The principal dimensions are as follows:—

Length, extreme,	446 ft.
Length on water line,	400 "
Breadth, extreme,	47 "
Depth,	29.76 ft.
Deadweight capacity,	2,032 tons.
Bunker capacity,	1,200 "
Gross tonnage,	4,409 "
Draft, mean.	16.5 ft.
Displacement,	5,650 tons.
Speed,	16 knots.
I. H. P.,	4,000

A double bottom is fitted, and the ship is divided by eight transverse bulkheads reaching up to the spar deck, into nine watertight compartments so that the vessel will remain afloat even if two neighboring compartments are flooded. The bulkheads have been built of special strength to the latest rules of the German Lloyds and of the "Seeberufsgenossenschaft." Three complete steel decks are fitted. The yacht is schooner

INBOARD ELEVATION AND SUN DECK PLAN OF PRINZESSEN VICTORIA LUISE.

rigged with two pole masts of steel and a yard on the foremast. On the spar deck, aft, is a deckhouse of about 36 feet length, amidships one of 239 feet, and forward a small forecastle, 23 feet long. Above the deckhouse amidships is the boat deck.

First-class accommodations only are provided, and 200 passengers can be carried in 123 cabins. The cabin arrangements and fittings are of comfortable and even luxurious style. There are 22 chambres de luxe, as well as 49 staterooms for one person each, 52 for two persons each, and 3 for servants. Below the main deck is the dining-saloon, with seating capacity for 200 persons. On the upper deck are found a saloon for conversation, a writing and reading room and smoking saloon. On the boat deck a full fledged gymnasium is fitted, while aft below the spar deck a dark room is fitted for amateur photographers' use.

As the yacht is intended for first-class passengers exclusively, all decks are at their disposal. In reference to the passenger cabins it is to be especially noted that no berths are placed over each other, and that their equipment is carried out in accordance with the long voyages in view. It need not to be mentioned that all occupied rooms are brilliantly lighted by electricity, steam heated, ventilated and provided with electric bells, etc. There are 1,060 incandescent lamps in all, the total capacity of the three generators being 84 kilowatts.

The galleys are arranged with all the latest appliances, while the numerous baths and closets are disposed in a suitable and convenient way for the passengers. The provision stores, refrigerating-rooms, ice cellars and luggage-rooms are placed underneath the lowest deck.

The yacht has six life boats and two large motor launches, the latter being at the disposal of the passengers in the various ports of call.

The propelling machinery consists of two vertical four-cylinder quadruple expansion engines placed in a

VIEW OF SPAR DECK, LOOKING AFT.

LADIES' ROOM.

PLEASURE YACHT PRINZESSEN VICTORIA LUISE.

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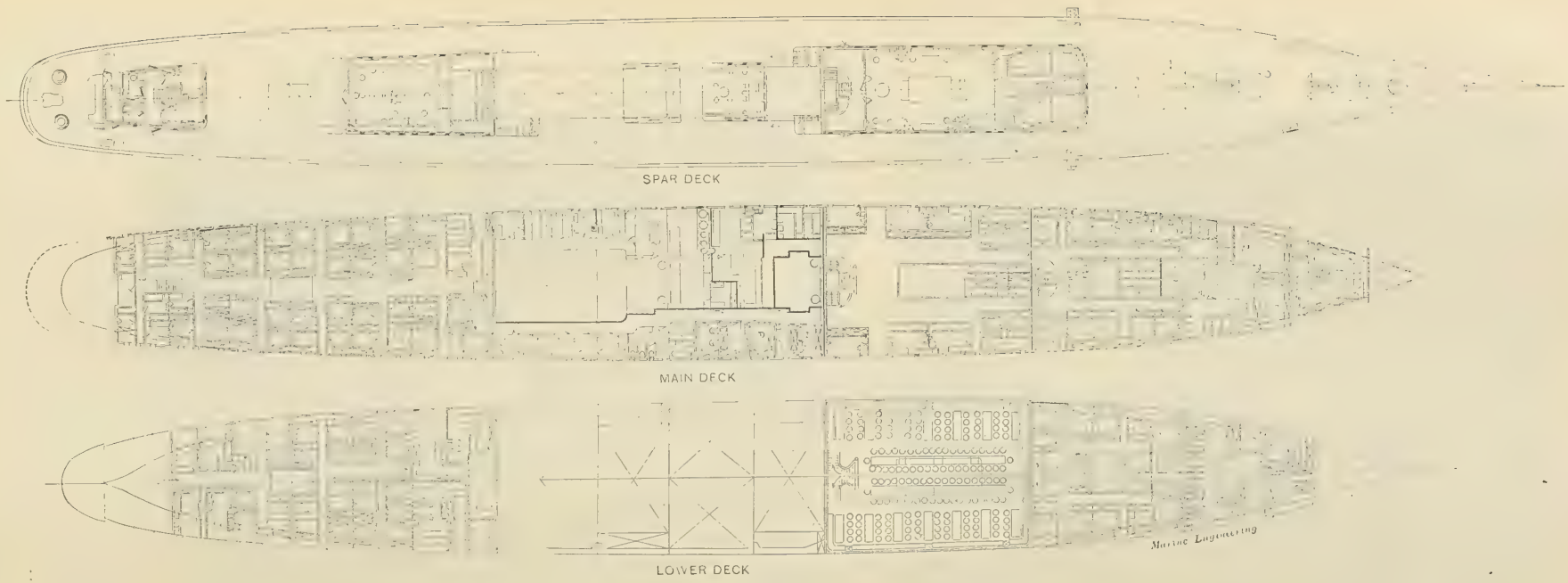

DECK PLANS OF YACHT PRINZESSEN VICTORIA LUISE.

common compartment. The high pressure cylinder is forward, the first intermediate pressure aft, and the second intermediate pressure and the low pressure between them, the low pressure being the forward one. The high pressure and the two intermediate pressure cylinders have piston valves, and the low pressure a slide valve. The crankshaft is in four sections, and the cranks at angles of 65, 94, 107 and 94 degrees with each other. The condensers are on the outboard side of each engine, and carry the back columns.

There are four single-ended boilers working under forced draft on the Howden system. They are placed in two compartments separated by a coal bunker, through which there is a tunnel for the passage of pipes. The arrangement of the blowers and air ducts is such that either set of boilers may be worked under forced draft.

The dimensions of the machinery are:—

Steam pressure	213	lbs.
Cylinders:		
H. P., diameter	19	in.
1st I. P., "	27.56	"
2d I. P., "	39.37	"
L. P., "	57.08	"
Stroke	36.22	"
Revolutions, estimated	120	
Center to center of forward pair of cylinders	5.64	ft.
Center to center of after pair of cylinders	5.64	"
Center to center of middle cylinders	9.84	"
Boilers:		
diameter	14.44	"
length	11.68	"
grate surface, total	230	sq. ft.
heating surface, total	9,688	" "
Furnaces:		
number in each boiler	3	
diameter, greatest	45.3	in.

Indicator diagrams taken on her first voyage showed 4,200 indicated horse power, with 123 revolutions per minute. The engines are particularly smooth in their working, and there is in consequence no vibration, thus adding greatly to the comfort of the passengers.

Floating Dock for the Spanish Government.

A large self-docking pontoon dock has been completed by Messrs. Robert Stephenson and Company, Limited, of Helburn-on-Tyne, England, and delivered to the Spanish Government at Port Mahon, on the island of Minorca. This dock was ordered before the late war, and was originally intended to be placed at the Naval Arsenal in the Philippines. The principle dimensions are as follows:—

Lifting capacity	13,000	tons.		
Length between perpendiculars	450	ft.,	0	in.
Breadth over pontoons	117	"	0	"
Depth moulded of pontoons	13	"	6	"
Cambre of pontoon side girders	0	"	9	"
Breadth moulded of side girders	12	"	2	"
Depth moulded of side girders above pontoons	38	"	6	"
Distance over side girders	115	"	4	"
Distance between side girders	91	"	0	"
Distance between shoring platforms	85	"	0	"

The specifications required that if a ship of 12,000

GYMNASIUM ON SUN DECK.

LIBRARY.

PLEASURE YACHT PRINZESSEN VICTORIA LUISE.

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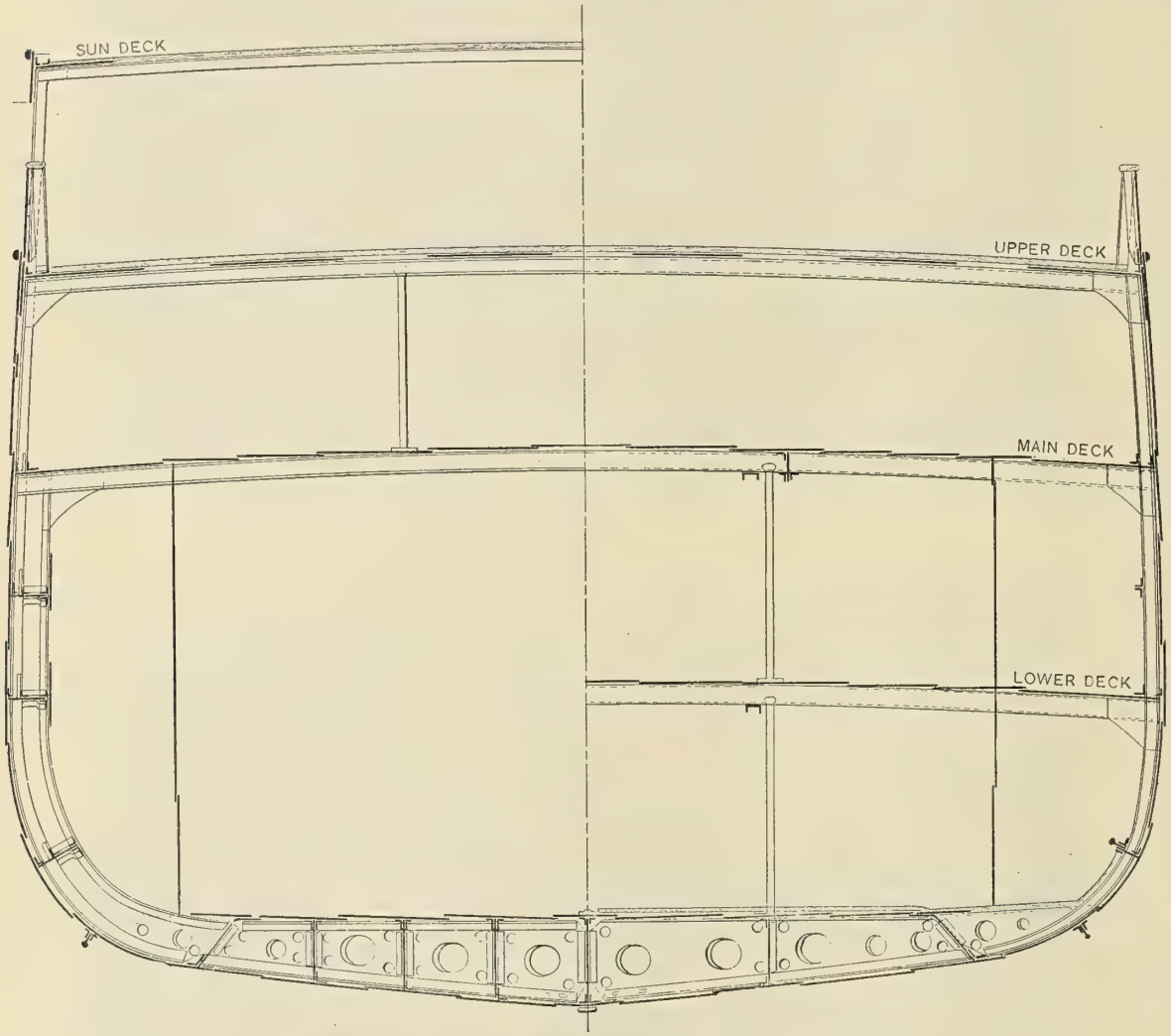
tons displacement and 328 feet long were placed at the center of the dock, no part of the dock should be under greater tensile stress than 6.33 tons per square inch, nor under a greater compression stress than 7.6 tons per square inch.

The pontoons, six in number, and of the above dimensions, are very strongly constructed of iron. There are eleven fore and aft bulkheads, nine of which are water tight, making a total of sixty water tight compartments in the six sections. Every fifth frame is a strong partial bulkhead extending across the dock, and



MIDSHIP SECTION OF YACHT PRINZESSEN VICTORIA LUISE.

over these frames the bilge blocks are placed. The keel blocks are supported by a 1-inch center girder, and by two fore and aft bulkheads on either side of and 4 feet from this girder. The pontoons are securely bolted to the towers, and also to each other by junction plates extending across the dock between adjoining pontoons. The towers are built of steel, and each is divided into ten water tight compartments. A safety deck is worked in about fourteen feet above the pontoons, to prevent the dock from sinking in case the inlet valves should by any chance be left open.

The pumping machinery is located in the central compartment of each tower, and consists of two large Scotch boilers working at 120 pounds, and two 24-inch centrifugal pumps built by Tangey, Limited, of Birmingham. There are also two duplex feed pumps and one duplex drainage and fire pump. The 26-inch main suction pipes run along within the towers and branch down at each pontoon to a collecting box, from which pipes lead to each compartment of the pontoon. The valves for each of these pipes are worked by rod and wheel from the top of side towers, and each compartment has a separate air pipe. Each of the centrifugal pumps is driven by a separate engine, and may discharge by means of valves from one or both ends of the dock. When all four pumps are working, two in each side tower, 23,000 tons of water can be discharged against a head of 28 feet, in two hours. The drainage pumps are also connected with each compartment by an independent line of piping.

The dock is so constructed that any one of the pontoons may be detached, drawn out from its place, and docked on the remaining sections. The dock was towed down the Tyne and around to Port Mahon, on the Mediterranean, a distance of two thousand one hundred miles.

MERCANTILE AUXILIARIES.*

BY THE RIGHT HON. LORD BRASSEY, K.C.B., D.C.L.

In bringing forward proposals for a more vigorous policy in relation to mercantile auxiliaries, I return to a subject in which, following the lead of Sir Nathaniel Barnaby and other authorities, I have long been deeply interested.

The history of the question may be briefly traced. The earliest contracts for the conveyance of the mails required that postal vessels should be suitable for conversion into armed cruisers. In 1853, upon the recommendation of the Committee on Postal Contracts, those wise stipulations were withdrawn. It is a notable circumstance that at the same date, iron was condemned as a material for the construction of fighting ships. After the lapse of a quarter of a century the subject was taken up by Sir Nathaniel Barnaby. His views were presented for the consideration of this Institution in a paper read in the session of 1877, on the fighting power of the merchant ship. Sir Nathaniel Barnaby insisted on the impossibility of providing adequately for the protection of our vast commerce with regularly built vessels of war. It was impossible to say what number of fast cruising ships would be sufficient for England, seeing that we should never know in what part of the world we should be attacked. It was necessary, therefore, to supplement—and largely to supplement—our regular cruisers with auxiliary vessels. Sir Nathaniel Barnaby's recommendations found powerful supporters.

Admiral Sir Frederick Gray spoke as follows: "Having been at the Admiralty and having felt the difficulty of providing, even in peace time, the force necessary to fulfil the various duties devolving on our ships of war, I think it would be utterly impossible to provide sufficient protection for our mercantile marine in time of war. I believe that the merchant steamers of England, if strengthened and fitted as proposed by Mr. Barnaby, would be very useful. I do not say that they would take the place of men of war, but they would be most useful as auxiliaries." In the same discussion Sir Spencer Robinson, then the Comptroller of the Navy, expressed himself in these words: "Those splendid ships which pass between the United States and England with very great speed and a coal-carrying capacity far exceeding the coal-carrying capacity you can give to any unarmored man of war, could be made capable of carrying such an armament as would protect them from the attacks of vessels of a similar class to their own."

These views of the naval advisers of the Admiralty, vainly urged a generation ago, have been fully shared, and practically adopted, by the naval advisers of foreign powers. I may quote the remarks of Admiral Fournier, in his able pamphlet, entitled, "La Flotte nécessaire." "As types of fast cruisers for the destruction of commerce, I know of nothing which more fully meets the requirements than those magnificent Transatlantic steamships, the *Lucania* and *Campania*, capable of maintaining a speed of twenty-two knots an hour, with extraordinary uniformity. The *New York*, *Paris*, *St. Louis* and *St. Paul*, and the English ships *Majestic* and *Teutonic* possess the same qualities, though in a somewhat less degree of perfection. Such ships will, in my view, be the destroyers of commerce in the future."

While their chief naval and technical advisers were endeavoring to obtain the assent of the Board of Admiralty to some practical action, the subject was not neglected out of doors. In 1878 a paper was published in the *Nautical Magazine* by the late Lord Inverclyde. I quote his weighty words, as true today as when they were written: "There never was a time in the history of this country when the subject of the efficiency of the Royal Navy occupied a position of greater importance than it does at present. Our risks lie in the fact that the fleets of other nations are fast becoming powerful and reliable; and whilst no navy can numerically approach that of this country, yet there are nations in Europe whose fleets combined would undoubtedly give us enough to cope with. How then can we stride ahead as the greatest maritime power, and hold our own against the fleets of the world? Not by being satisfied with increasing the strength of the Navy proper, which, owing to the prodigious cost of modern war vessels, can only be done in a comparatively small degree. But what cannot be accomplished in that direction can be attained by other means ready to our hand, and that by utilizing the vessels of the Mercantile Marine."

At the date of Lord Inverclyde's paper the cost of our most powerful cruisers was under a quarter of a million. The cost of the first-class cruisers we are now building is more than threefold greater. The practical steps which Lord Inverclyde recommended to the Admiralty are briefly described in his paper. There was wanted a scheme by which the advantages of the vast fleet of merchant steamers now belonging to the country should be conserved for our special requirements, and it was due to our naval authorities to admit that they had recognized that there were numerous British vessels which could easily be converted into cruisers. There was, however, one fatal flaw in the Admiralty plan. They wanted to have the use of the ships without paying an adequate consideration! As Lord Inverclyde put it: "It was not to be supposed that a position for their vessels on the select list would be a sufficient inducement to comply with Admiralty requirements, and to incur the expense involved in exacting the requisite alterations. War being only a contingency more or less remote, a retaining fee must be offered." It was proposed by Lord Inverclyde that subsidized steamers should be built to meet certain requirements, including increased bulkheads and watertight compartments. The ships should be manned by seamen of the Royal Naval Reserve, who should be thoroughly trained in gunnery at the respective home ports of the companies or owners.

The subject of mercantile auxiliaries continued to attract the attention of our highest authorities on naval administration. In 1880 Sir Donald Currie read an exhaustive paper at the United Service Institution. He referred to the general increase in naval preparations. France had increased her navy; Germany and Russia were making large strides in the direction of more powerful naval forces. Quite recently the Russian volunteer fleet had been originated by Prince Dologo-

* A paper read at the meeting of the Institution of Naval Architects, June 25, 1901.

rouki, the Governor-General of Moscow. He addresed himself to the wealthy merchants of that ancient capital, appealing to their patriotism, and a Volunteer Cruisers' Fund had been raised. Sir Donald Currie submitted a scheme for the retention of swift merchant cruisers by an annual subsidy.

I may refer to another shipowner, most eminent in that branch of enterprise with which he was connected. I refer to the late Mr. Ismay. In the evidence which he gave before the Royal Commission on coaling stations, he truly said, "When a company has not been doing well, and has got heavy bills running, which it cannot meet, the temptation to shut its eyes to what would be the ultimate destination of ships sold to foreigners in a crisis would be very great. At the commencement of the Russian scare, on the occasion of the Penjdeh incident, great temptations were offered to the owners of the White Star steamers running between San Francisco and Japan, and it was not too much to say that our whole commerce in the Pacific would have been transferred to the flag of the United States, if that offer had been accepted." The British ownership of a magnificent steamship is a slight national tie. It binds to no national service while it exists, and it may be broken without warning, at the will of the owners. These considerations may be pleaded as a strong argument in support of the policy of binding all our finest vessels to the service of the state as mercantile auxiliaries.

Passing on to the later authorities, the practicability of so constructing merchant steamers as to render them readily available for war purposes was discussed by Mr. Biles in a paper read at an engineering conference, held under the auspices of the Institute of Civil Engineers, in June, 1899. Arguing from the results of arming and fighting the mercantile cruisers of the United States Navy, Mr. Biles takes the view that such vessels are not unable to cope with thoroughbred warships. The experiences of modern sea fights point to the conclusion that a ship is more likely to be disabled by her crew being driven from their guns than to be sunk by the effects of shell fire. The issue of a fight between a warship and a merchant ship may not turn on the relative efficiency of the internal subdivision, but on the protection of the guns. By placing the guns in a box battery, as the Americans did, a considerable number of guns could be as well protected in merchant ships as in first-class cruisers. Mr. Biles holds it to be practicable, with due consideration in the early stages of design and construction, to so protect machinery and armament, that the merchant ship need not be much, if at all, inferior to many warships.

The policy of liberal subsidies to the Mercantile Marine has given to the merchant navies of foreign powers a decided advantage in the possession of the types of vessels most suitable for naval purposes. The Germans have taken the lead. They have two ships now running, the *Deutschland* and the *Kaiser Wilhelm*, of 14,000 tons and 15,000 tons respectively, which exceed in speed by nearly two knots our best ships. No vessel now building for the British flag will rival in speed the *Kaiser Wilhelm II.* and *Kronpriz Wilhelm* under construction in Germany.

Of ships capable of a regular sea speed of over 18 knots, France has four, Germany eight and Great Britain ten.

Taking vessels above 3,000 tons only, Lloyd's statistics, as quoted by Mr. Biles, give the relative position as follows:—

	British.	Foreign.
20 knots and over.....	6	6
19 to 20 knots.....	1	11
18 to 19 knots.....	9	4
17 to 18 knots.....	22	18
16 to 17 knots..	17	18
	55	57

It is an ominous fact that in the last eight years we have added only one ocean-going 18-knot ship to our Navy, while Germany has built four in the last four years. It is another ominous fact that, while we equal the combined merchant navies of the world in aggregate tonnage, of the 157 ships of 16 knots and over, less than one-half the number are under the British flag. If we examine the lists of mercantile auxiliaries of the several powers, we find that France has thirty-two vessels, the latest additions, the *Lorraine* and *Savoie*, having a displacement of over 11,000 tons. The speeds of the French subsidized steamers have been constantly increasing from the 15 knots of twenty years ago, to the 17, 18 and 19 knots of modern types. The armaments provided for each ship include seven 5.5 inch guns and smaller quickfirers. In numbers the German auxiliaries do not compare with the French. There are, however, six ships of the first class, which, at it has already been observed, hold the record in the international competition on the North Atlantic. The armaments prepared for the German mercantile auxiliaries include eight 5-inch guns, four 4.7 inch, four smaller quick-firers and fourteen machine guns. The Russian fleet of auxiliary steamers consists of twenty-five vessels. In displacement eight of these ships exceed 10,000 tons with speeds of 19 1-2 to 20 knots. The British list of reserve merchant cruisers compares unfavorably with those of foreign powers. It consists of twenty-nine vessels, none being fitted with special protective arrangements.

With these comparisons before us, we must regret that so little heed should have been paid to the counsels of the able men to whom I referred in the opening of this paper, how little is attested by the fact that the amount payable to the owners of our reserve merchant cruisers under the Naval Estimates now before Parliament is £63,000, out of a total of £32,000,000 which Parliament is asked to vote for the Navy.

While we have taken no adequate measures to create a fleet of mercantile auxiliaries by the appropriation of moneys directly voted from Navy Estimates, we have been sparing in our grants for postal services. The amounts paid have been computed by Mr. Henniker-Heaton, M. P., as follows:—

Countries.	Money.	Total Value of the Foreign Trade.
France	£1,143,000	£300,000,000
Germany	1,000,000	313,000,000
Russia	251,000	111,000,000
Italy	400,000	182,000,000
Great Britain	637,000	750,000,000

The latest returns show no material changes in the figures given by Mr. Henniker-Heaton.

And now, let us ask ourselves what steps it is practicable to take in furtherance of the policy which it has been the object of the present paper to recommend; and, first, what is the proper sphere of action of the mercantile auxiliary? It was described by Lord George Hamilton, in moving the Navy Estimates for 1889. They would be employed in dogging the footsteps of a foreign rover, and embarrassing a foe; they would act as the scouts of the fleet. The difficulty of keeping touch with a squadron has been strongly impressed in recent manoeuvres. As scouts and patrol vessels their long coal endurance would give to the mercantile auxiliaries an advantage over regularly built vessels of war of even tonnage. Such being the rôle of the mercantile auxiliary, the qualities required are speed, coal endurance, internal subdivision up to Admiralty requirements, strength of hull. Guns must be carried at such a height above water as to be of service in a seaway. Lastly, there is the absolute requirement of protection from the shot and highly explosive shell of quick-firing guns. The power of modern armaments to reduce unarmored superstructures to wreckage, to disable guns, and annihilate guns' crews has been signally shown in the battles of Manila and Santiago.

If the requirements were carefully considered in the original design, it would be possible to give as much, or nearly as much protection to the mercantile auxiliary as to the regularly built cruiser. Mr. Peskett, of the Cunard Company, has recently offered some practical suggestions on this subject in a lecture delivered at Liverpool. Mr. Peskett is a strong advocate for subsidies to mercantile auxiliaries, conditional upon the adaptation of the ships to the requirement of naval warfare. I may quote from a précis of his lecture: "Merchant ships of the *Campania* or *Saxonia* class could actually be built lighter than they are under the present system, if they were built with one very strong deck, such as a protective deck with sloping sides, or with a deck of cellular form. The disposition of material in some of our large steamers is not perhaps in strict accordance with the best designs our naval architects could produce, but entirely due to the requirements of owners, and the various registration societies. I should say that a cruiser's hull, with protective deck, is lighter in proportion to her displacement than that of many of our first-class passenger steamers.

"Taking into consideration the fact that our supremacy depends on the efficiency of our Naval and Mercantile Marine, a committee of Admiralty officials, shipowners, and shipbuilders should be formed to discuss the best method of constructing a combined Naval and Mercantile Marine, and to consider whether ships could be built as merchant cruisers, with protective decks, ram stems, machinery and steering gear below the water-line, and still be able to carry enough passengers and mails, which with a reasonable subsidy would make the ships remunerative to owners.

"These ships would have to be permanently mounted with light guns, racer plates for heavier armaments being built in the ships during construction, the heavier guns and mountings being kept at ports of call, and made to suit the various ships of any particular fleet."

It has always been recognized that mercantile auxiliaries cannot be effective unless specially designed for conversion into cruisers. In the discussion at the Institute of Naval Architects on Mr. Barnaby's paper already referred to, Sir Edward Reed proposed that shipowners about to build large and swift merchant vessels should be invited to submit their plans to the Admiralty. The cost of any alterations which they might be willing to make in order to adapt these vessels for the emergency of war service should be met by a grant from the Government.

It is the main object of the present paper to urge the adoption of valuable and practical recommendations, which have been too long neglected. It is the fixed resolve of the people, and, perhaps the first duty of British statesmen, to keep the Empire secure from attack, and to give protection to the commerce on which our existence depends. In pursuance of this policy we have more than doubled the expenditure under Navy Estimates, and still we seem to fall short of the full requirements for the naval defence of the Empire. It would be impossible to fix a limit to the number of cruisers required for the protection of a commerce which extends over every sea. The construction of cruisers has absorbed in recent years a large proportion of the shipbuilding votes. But when the cost of the first-class types falls little short of that of the battleship, the numbers we can build are all too few for the work they might be required to do. We cannot cut down the expenditure on battleships.

If, therefore, our regular built cruisers are fewer than we could wish, we must look to our own Mercantile Marine, and, out of the abundant materials we there find ready to our hands, we may organize a supplemental fleet of armed cruisers such as no other state can furnish. The Admiralty should utilize these resources by liberal subsidies. The standard of requirements should be high. The speed should not be less than that of the *Deutschland*—let us say, 22 knots at sea. Mercantile auxiliaries should be protected by a deck or belt of Harveyized armor—the necessary armaments should be in readiness. Calculations of cost can hardly be attempted in a paper in which nothing more is attempted beyond suggesting a policy. This, at least, is certain, that the cost of the adaptations and protective arrangements necessary in a mercantile auxiliary will be small in comparison with the first cost of a regularly built vessel of war. For a first-class cruiser we may take the cost at three-quarters of a million. Allowing 3 1-2 per cent on the money invested, adding 6 per cent for depreciation, and 1 per cent for insurance, we have in round figures for the first cost an annual writing down charge of £70,000 a year.

In addition, there is the cost of maintenance, which, whether in commission or in reserve, will certainly be considerable. Allowing for the protective arrangements of the mercantile auxiliary the liberal sum of £50,000, and a writing down charge on this amount of 10 per cent, and taking 10s. per ton displacement for the annual retainer, we have, for a mercantile cruiser of 10,000 tons, an annual charge of £10,000. We must further take into view the economy resulting from the maintenance of the mercantile auxiliary by the shipowners, as against the maintenance of the man-of-war in our Royal yards. In conclusion, I claim that it has been clearly shown that we can have many auxiliaries for the cost of one cruiser; and these auxiliaries may have effective protection. If not equal to the ship of war as combatants, they will be superior in coal endurance and probably in speed for long distances. They would be the scouts of our fighting squadrons. They would protect our commerce from interruption by the auxiliary vessels of a hostile power.

While the building of cruisers for the Navy should be continued, the resources we possess in the marine, which our maritime enterprise has created in extent practically without limit, should not be neglected. Here, in Glasgow, I look for powerful support to a policy not now presented for the first time to the consideration of the Institute of Naval Architects. It has been advocated for many years by your ablest men; it is being steadily pursued, to their signal advantage, by every naval administration: we are lagging behind, how seriously, has been shown by the figures which I have quoted. If the expenditure on auxiliary cruisers were raised from £60,000 to £600,000 a year, in a few years we should be enabled to provide no ineffective protection for our vast trade.

The United States Frigate Hartford.

The old *Hartford* is one of the few historic remnants left of the wooden navy. The picture on the opposite page is from a recent photograph, and shows her as she now appears.

Her career during the Civil War, and especially as Admiral Farragut's flagship at Mobile Bay, is too well known to call for extended notice, but as the last of her type it may not be without interest to review briefly the chief features of her public service.

The *Hartford* was built at the Boston Navy Yard, and was launched in 1859. The chief dimensions were: Length, 225 feet; beam, 44 feet; displacement, 2,550 tons. The machinery was built by Loring and Coney, of Boston, and consisted of a direct acting two-cylinder jet condensing engine with cylinders 62 inches in diameter by 34 inches stroke, with two Martin boilers, having 253 square feet of grate surface and 7,600 square feet of heating surface. The propeller was of bronze, two bladed, 14 feet in diameter and 25 feet pitch. This propeller was replaced in 1880 by one of four blades, and the old one was used as material for the statue of Admiral Farragut which now stands in Farragut Square, Washington, D. C.

The first cost of the *Hartford* was about $500,000.

Her first service was on the East India station, where she served as flagship. Recalled early in the Civil War, she saw active and severe service in the Gulf squadron, serving as Admiral Farragut's flagship in the Mississippi River and at Mobile Bay.

At the close of the war she was sent to the Asiatic station, where she served for a part of the time as flagship. In 1875 she returned home by way of the European station, stopping on the way to aid in adjusting some questions with Tripoli. Her next station was on the North Atlantic, where, in 1876, she was flagship. From here she went to the South Atlantic station, also as flagship. In 1879 she again returned home, and after refitting at Boston was sent in 1883 as flagship on the Pacific station.

During this re-fitting in 1880 the *Hartford* was given new machinery, consisting of a pair of Isherwood engines, 60 inches diameter by 36 inches stroke, which had been built by Harrison Loring during the war for a sloop—the *Kewaydin*—which was never completed.

The tour of duty on the Pacific Coast was the last regular assignment of the *Hartford*. After this cruise in 1889 she was surveyed, and it was reported that the necessary repairs would exceed the 20 per cent limitation allowed by law. She was therefore condemned and ordered sold.

The people of California, however, together with others, through a special effort, succeeded in securing from Congress legislation which gave an appropriation of $576,000 for the reconstruction of the *Hartford*. Of this sum, $276,000 was to be used on the hull, $150,000 on the machinery and $150,000 on armament.

The new machinery consists of a compound engine with cylinders 35 inches and 68 inches diameter and 48 inches stroke. The designed I. H. P. is about 2,000 at 75 revolutions per minute. The boilers are four in number of the single end Scotch type, 11 feet 1 1-2 inches diameter and 10 feet long, constructed for a pressure of 110 pounds per square inch. The total heating surface is 6,340 square feet.

In reconstructing the ship the original lines were preserved, and as much as possible of the old wood was worked into the new hull. At the same time care was taken that only sound and durable material should be used, and in her present form she is doubtless good for many years of service.

In the reconstruction of the hull the old spars were removed and new ones substituted, much lighter in size and suited for training-ship purposes, for which she was chiefly intended. For armament the old 9-inch smooth-bore guns were removed, and she now has a modern battery of fifteen 5-inch rapid-fire guns, four 6-pounders, one 3-pounder and two Colt rifles.

Thus reconstructed, the *Hartford* left Mare Island January 10, 1900, for this side of the continent, arriving at Fortress Monroe on May 10th, and later visiting various points on the North Atlantic Coast. She is now cruising as a training ship in European waters with an itinerary which will bring her home again in the late fall.

Wireless Telegraphy.—A wireless telegraph station has been established on board the Nantucket Lightship for reporting incoming steamers. Many of the Atlantic liners have this system installed, and these can send ahead reports of their passages several hours before they reach the lightship.

UNITED STATES FRIGATE HARTFORD.

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DETAILS OF CONSTRUCTION OF THE FAMOUS AMERICAN CLIPPER SHIP "GREAT REPUBLIC."

(*Continued from page 324.*)

"The upper deck waterways are 12 by 13 inches, with one strake inside of them of 8 by 13 inches, and the waterways, like the work below, are coaged and cross-bolted and scarphed; and the ceiling above is 3 1-2 inches thick, and the clamp under the spar deck beams is 6 by 14 inches. The outline of the upper deck above the waterways is covered by a planksheer of 7 inches thickness, and the covering board of the spar deck is 7 inches thick and 20 inches wide, and on this is a chock of 12 by 6 inches, and into it are mortised the turned stanchions, which, with a rail that is 3 1-2 feet high and 5 by 12 inches square, protect the outline of the spar deck.

"Her garboards are 10 by 14 inches, let into the keel, and are bolted through it and each other, and square fastened through the timbers; the next strake is 9 inches thick, and the third 8 inches, champered off to 6 inches, the substance of the planking on the bottom; the bilge is covered with 8 inch thickness; the wales are 6 by 8 inches, up to the moulding below the planksheer, and the waist is 4 1-2 inches thick. The outside is square fastened with treenails, is extra copper bolted, and finished smooth as glass.

"The beams under the lower and main decks are 15 by 16 inches amidships, and under the upper deck 12 by 15 inches, but twenty-five of the upper deck beams are double, bolted together, and side 22 inches, and the spar deck beams vary in size, but are very close together. There are thirty-eight beams under the lower deck, forty under the main deck, forty-one under the upper deck, and eighty-nine under the spar deck. The hanging and lodging knees connected with the two lower sets of beams are of oak, and those with the beams above are of hacmatack. The hanging knees are sided from 10 to 13 inches, moulded from 22 to 24 inches in the throats, have from 5 to 6 foot bodies and 4 to 4 1-2-foot arms, and have twenty 1 1-4-inch bolts and four spikes in each. The knees under the spar deck, like the beams, are light and are all diagonal, and the lodging knees, connected with the beams below, are sided 8 inches, are scarphed together in every berth and closely bolted. All the ceiling between the main and upper decks has diagonal, hard pine braces, extending from the throat of one hanging knee to the foot of the other, from forward to aft, and these braces are bolted through the ceiling and the timbers. The upper deck fore and aft framing, usually square in other ships, is diagonal, between every beam, the diagonals fayed to the beams and carlines, and the beams are also kneed amidships to the central fore and aft framing, which is 8 by 14 inches, and to which there are 144 knees. The spar deck is of white pine, 3 inches thick, and the other decks are of hard pine, of 3 and 3 1-2 inches thickness, and the thick strakes amidships and over the wing stanchions are coaged and bolted through the beams. She has 1,650 knees in all.

"She has three tiers of stanchions, which extend from the hold to the main deck beams, and which are fitted around the lower deck beams, as if they had been rove through them, and these are in two pieces, which, combined, are 10 by 23 inches. The wing stanchions are stepped into the bilge keelsons and double kneed to them, and the midship stanchions are stepped into the upper keelson, and are kneed fore and aft, the knees scarphed together in every berth, thus forming a rider over the upper keelson.

"The stanchions under the corners of the main hatchway are clasped with iron to the beams, and like the others are continued to the deck above.

"The stanchions under the other decks are of oak turned, secured with iron rods through their centers, which set up with screw nuts, and are 10 inches diameter.

"Her hooks and pointers are of white oak. In the hold forward are three sets of pointers, from 30 to 40 feet in length and of 9 by 11 inches in substance, and, except the lower pair, which fay into the angles between the keelsons and the skin, are filled in with hooks, cross all the cants diagonally and fay to the lower deck beams. In addition to these, about 5 feet above the keelsons, is a horizontal hook shored off with two beams, and to each beam there are four knees. The after end is secured in the same style, and the knees under the deck are very stout, and extend well aft and forward.

"The chain lockers, as already stated, are in the hold, near the foremast; and the iron water tanks, which extend to the upper deck, and are cylindrical in form, are placed, one 64 feet before the main mast, and the other 24 feet abaft it, and rest upon massive beds, strongly bolted, and the stanchions before and abaft them are kneed on the sides to the keelson. The mast steps are of oak, and are also very strongly bolted; and the pump wells, for she has four hold pumps, are large and well secured. The bow, between the lower and main decks, is spanned by a heavy hook, which extends along the sides to the fourth beam, and is braced off by two beams, kneed like those below—that is, four knees to each beam. The after hook is beamed and kneed in the same style, and the after hook between the decks above is built double around the curve of the stern, and is also beamed and kneed to the distance of the fourth beam before the stern post. Between the main and upper decks her bow is spanned in the same style, with hooks, beams and knees, and over and under the bowsprit, which is stepped on the upper deck, the angles of the bow are filled with heavy hooks. Her ends, like every other part of her, have been secured in the strongest style. All her hatchway combings and mast partners are kneed to the beams, and every thick strake on all the decks, as already stated, is coaged and bolted through the beams, so that it seems almost impossible for any part of her to work loose while her materials endure.

"She is ventilated upon a new principle. A plank is open along the sides of all the houses on deck, with glass below, so that the air acting upon the sides of the houses will follow the ventilators into the decks below on one side, and escape through those on the side opposite, thus keeping a continued current of air passing from side to side through every deck and the hold. These ventilators also answer for skylights, and are so arranged that water cannot enter them.

"The ship has four masts, the after one named the spanker mast, which is of a single spar; the others are built of hard pine, the parts doweled together,

bolted and hooped over all with iron. The bowsprit is also built and hooped in the same style, and the topmasts and jibbooms are of hard pine. She has Forbes' rig, and is square rigged on the fore, main and mizzen masts, and fore and aft rigged on the spanker mast. The main yard is 120 feet square, and the lower maintopsail yard 92 feet. Excepting these, all the other yards above are alike on the fore and main masts, and the lower foretopsail yard is of the same dimensions as the crossjack yard, and all the yards above are alike on both masts. The following are the dimensions of her masts and yards:

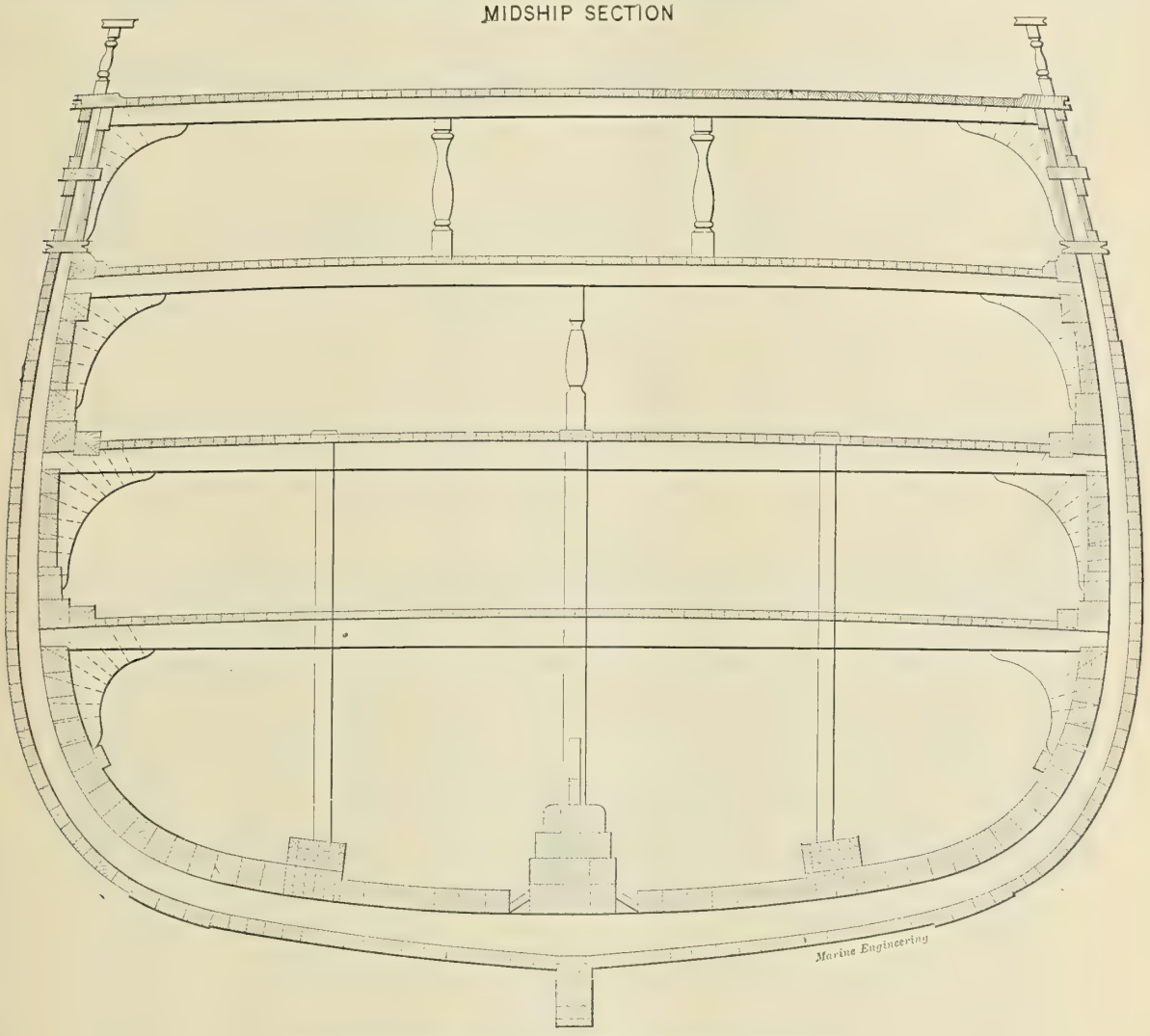
MASTS.

	Diameters. Inches.	Lengths. Feet.	Mastheads. Feet.
Fore	44	130	36
Top	24	76	12
Topgallant	18	28	0
Royal	15	22	0
Skysail	11	19	pole 12
Main	44	131	36
Top	24	76	12
Topgallant	18	28	0
Royal	15	22	0
Skysail	11	19	pole 12
Mizzen	40	122	33
Top	22	69	10
Topgallant	16	22	0
Royal	10	19	0
Skysail	8	15	pole 8

YARDS.

Fore	26	110	yard-arms 6
Lower top	24	90	5
Upper top	19	76	4½
Topgallant	15	62	4
Royal	12	51	3½
Skysail	9	40	3
Main	28	120	6
Lower top	24	92	5
Upper top	19	76	4½
Topgallant	15	62	4
Royal	12	51	3½
Skysail	9	40	3
Crossjack	24	90	5
Lower mizzen top	19	76	4½
Upper mizzen top	15	62	4
Topgallant	12	51	3½
Royal	9	40	3
Skysail	6	29	2

MIDSHIP SECTION



MIDSHIP SECTION OF THE CLIPPER SHIP GREAT REPUBLIC.

"The spanker mast is 26 inches in diameter, 110 feet long, including 14 foot head, and the topmast is 40 feet long, divided at 15 and 10 feet above the cap, for the gaff topsail and gaff topgallant sail. The spanker boom is 40 feet long, including 2-foot end, and the gaff 34 feet, including 8-foot end. The bowsprit is 44 inches in diameter and 30 feet outboard; the jibboom 22 inches in diameter and 18 feet outside of the cap, with 4-foot end, and the flying jibboom is 14 feet long, including 6-foot end. Her fore and main rigging and

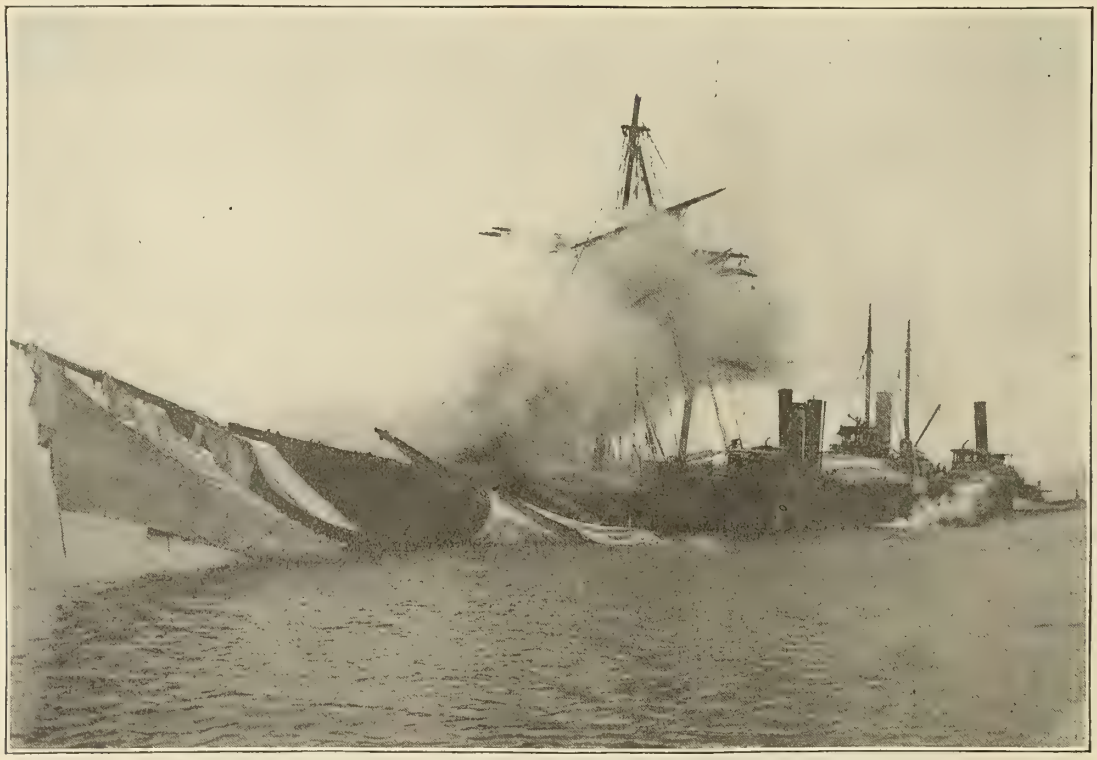
fore and main topmast backstays are 12 1-2 inches patent rope, wormed, and served over the eyes, and over the ends to the leading trucks. The mizzen rigging and mizzen topmast backstays are of 11 inches, and the fore and main topmast rigging is of 8 inches.

"She has six shrouds on a side, for the lower rigging over the trestle trees, and two shrouds on each side from the caps at the extremes of the lower mast heads. There are four shrouds on each side for the topmast rigging, three topmast after backstays, and shifting breast backstays, double topgallant and royal backstays, with outriggers in the topmast crosstrees; and there are also outriggers in the tops for the topmast breast backstays. The lower and topmast stays are double, and she has also capstays leading from the extremes of her lower mastheads on deck. The fore stays set up to the knightheads, and her topmast and jibstays lead in through the bow and set up in board. She has iron futtock rigging, chain bobstays and bowsprit shrouds, martingale stays and guys, and topsail sheets and ties. She has iron patent trusses, and iron jackstays on all the yards. As the topmasts are fidded before the heads of the lowermasts, the lower topsails set upon the heels of the topmasts, between the tops and the caps. She has pole topgallant, royal and skysail masts, which are in one spar, and are also fidded forward to the topmastheads; and her tops are of solid oak.

"Her sails are made of cotton duck. There are double reefs in the courses and lower topsails, and single reefs in the upper topsails and topgallant sails. The topsails and courses are roped along the reef bands, and are also cross diagonally banded and roped between every reef, and from opposite clews to opposite earings over their whole surface. They are also belly banded and roped at regular distances their whole depth. All the rope of her sails is of Manila hemp, and the leech and foot ropes of her topsails and courses are of 8 1-2 inches. She has no lower swinging studding sail booms, for her lower studding sails are triangular, terminating in a point at the rail, and, consequently, will set better and can be carried longer than if they were square.

"Harris's lightning conductors are applied to all her masts; in fact, nothing has been omitted in her outfits aloft that could be considered of the slightest utility. Aloft, as well as below, she is all that a ship ought to be, in strength, beauty and completeness.

"She has three hawse holes and four anchors. Her best bower is of Porter's patent, and is 8,500 pounds weight, the working bower is 6,500 pounds, the small bower or stream anchor 2,500 pounds, and the kedge 1,500 pounds. Her bower chains are each 2 1-2 inches, and each 120 fathoms in length; the stream chain is of the same length and of 1 1-2 inches in size, and she has two hemp stream cables and several hawsers."



THE AMERICAN SHIP COMMODORE T. H. ALLEN ON FIRE IN NEW YORK BAY.

As the description was written before the *Great Republic* went to sea, it contains no record of her performances. We are otherwise informed, however, that later she was destroyed by fire in New York harbor, after having proved a very fast and profitable ship. If any of our readers have data on this point we shall be very glad to receive it.

Shamrock II.—The *Shamrock II.* has arrived at New York, after a passage of fifteen days, and is now being overhauled at the Erie Basin, Brooklyn, preparatory to the races.

American Clipper Ship Burned.

While the American full-rigged, three-masted clipper ship *Commodore T. H. Allen* was being towed down the Swash Channel out of New York bay on July 18th, smoke was discovered coming out of the second cargo hatch. The *Allen* was leaving for Hong Kong with a cargo of case oil and paraffin wax under charter to the Standard Oil Company.

THE COMMODORE T. H. ALLEN IN DOCK AT HONG KONG.

The captain signalled to the tug which was towing, to turn back. The clouds of smoke now pouring from the forward hatchways were increasing every minute and attracted several tugs and the pilot boat *New York*. These came along side and pumped streams of water into the burning holds, and later a wrecking tug and fireboat came down from New York, but the combined streams of all the craft could not quench the fire, so the ship was beached inside of Sandy Hook and flooded. The wax was stored on the upper 'tween decks forward, and from that deck up the forward part of the ship was totally destroyed, the fire burning through the sides at some places and reducing the frames and side planking to charcoal. The foremast fell with all sails set, for when the fire broke out the headsails and most of the square sails had been spread.

This fine ship was built in Richmond, Me., in 1884. and from that date until this accident had not met with a single mishap. She is 240 feet 4 inches long, 41 feet 8 inches beam, 19 feet 9 inches deep, and of 2,390 gross tons. Her captain and part owner, Mr. Robert L. Merrimen is on record as the oldest captain in the service. The ship is now discharging the unburned cases of oil at Erie Basin, and will probably be turned into a barge.

Naval Divers.—The British Admiralty has built a diving tank at the Gunnery School, Whale Island, where men selected from the navy are given their first lessons in diving and the use of the diver's apparatus.

LAUNCH OF THE MALLORY STEAMER DENVER.

On April 14th a launch of more than ordinary interest took place at the works of the Harlan & Hollingsworth Company, Wilmington, Del.

The special conditions of this launch were the large dimensions and great weight of the vessel, and the narrow stream into which she was launched.

These conditions, although somewhat difficult to contend with, were very successfully met, and the present article will treat of the method employed, in addition to the outline of the dimensions and the general arrangements.

The *Denver*, which was built for the Mallory Steamship Company, of New York, rested on the ways at an inclination of about three-quarters of an inch to one foot, and her gross weight at the time of launching was about twelve hundred tons. This being spread over about six hundred square feet of way surface, gave a pressure of about two tons per foot. The frictional resistance being reduced to a minimum by the application of a nearly perfect lubricant, this weight combined with the declivity, promised a very speedy launch. As the width of the Christiana River at this point is small, being hardly one and a half times the length of the *Denver*, with an expanse of mud flats on the opposite side, the question of bringing the boat to a standstill in a little over her length required considerable attention. Having knowledge of the method of "snubbing" employed with satisfactory results by various shipbuilding yards on the Clyde, this firm decided to put that method to the test for the launch of the *Denver*.

The method referred to is that of using "drags," or improvised anchors, along the ground, attached to the bow of the ship by huge chains or cables. As this is an entirely new arrangement at this yard, if not in this country, it was in the nature of an experiment that the plan was carried out, and it was watched with a great deal of interest by various shipbuilding men of this locality. The drags employed were eight in number, four on each side, their initial position being about abreast of the stern of the boat at a distance of about thirty feet out from the center line. The interval between the four drags was about ten feet. The disposition of the weights among the four drags, if properly carried out, tends to the attainment of the best results and is a very important feature of this method. A proper amount of slack chain or rope between the drags is also an important detail. Designating the drags by the letters A, B, C, D, the drag A being nearest the dock line, the drag A should be lighter than B, and B lighter than C, and so on to D, the last drag to take up the strain, which should be the heaviest of all. This insures a gradual taking of the strains, the slack chain between the drags playing an important part, and nearly eliminates the tendency to any sudden shock and the consequent danger of breaking the chains or cables. The importance of this was not realized in the case of the *Denver*, but the experience gained augurs well for future launches.

In the launch in question the drag A weighed about twenty-two tons, B about eighteen tons, C and D about eight tons apiece, making about fifty-six tons on each side, or one hundred and twelve tons as the total weight of all the drags. The disposition of the weight, however, was not such as to obtain the best results, although the method as a whole was efficient.

In building up the drags considerable experience was also gained, which will be of use in the future. On the starboard side the drags A and B were made with a foundation of old chain worked back and forth over end pieces of bulb angles, to which were attached the leading and dragging chains. On top of this bed of chain, pig iron was piled uniformly until the required weight was in place. Owing to this construction these drags were not as efficient as was expected. The pig iron had nothing to keep it in place, and consequently when the sudden shock was brought upon them these drags practically spilled nearly all of the pig iron in the vicinity, and the remainder all along the path of the drag. Owing to this decrease in the weight, the major portion of the work was thrown upon the two remaining drags as far as the starboard side was concerned. These drags, C and D, were the housings of old plate mills, and consequently held intact.

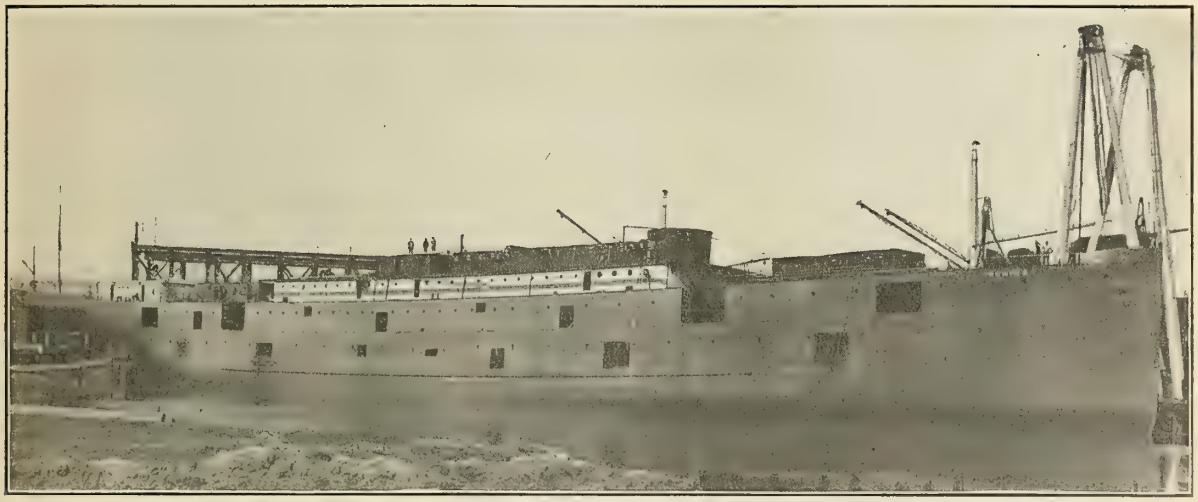
On the port side a different condition of affairs was encountered with more successful results. The drags A and B on this side received more attention and were built up like box sleds. Old rail bars, four in number, were used as runners, turned up at the front end, and on top of it a sort of metal box was secured. Plates, tie rods and angles were used in the construction of these boxes, and they were then filled with pig iron to the required weight. The same arrangement of leading and following chain was carried out in each case. To provide against the possibility of the one towing chain breaking, separate direct leads were carried from the main towing chain to each drag. The main chain was an old one borrowed from a steamer in the dock at the time, and was a one and three-quarter inch chain. An auxiliary cable of wire rope was also provided and proved of great assistance.

The action of the drags on the port side was entirely different from those on the starboard. The branch chain to drag A parted, leaving that drag stationary. The slack chain being taken up, the drag B started on an erratic course. The drag A being in the road, there was nothing to do but to ride over it, and this it did, somewhat to one side, still maintaining its equilibrium. The path of this drag was plainly noticeable as far as the edge of the dock, where it ended its journey. Owing to the climbing feat it had performed, the drag B was thrown on a course nearer to the center of the ship than was originally intended, and it is due to this fact that its path was visible. It ploughed the ground all along and went through nearly all of the ground way shores, remaining intact throughout its course. As on the starboard side, the drags C and D were old mill housings, and remained intact throughout their travel, which was not very far.

The chains attached to these last drags parted from one on one side, and the other two were carried about one-half of the distance, but there is no doubt as to their lending some weight to the retarding of the ship.

The main chain, as previously stated, was of one and three-quarter inch wire, and was attached by means of a huge shackle to the various chains leading to the drags.

The method of securing the chain to the vessel was a question demanding considerable attention, as the great shock must not damage the hull, and the lead of the chain must needs be carried out from the center line, so as to preclude the possibility of the drags damaging the keel blocks by being drawn in towards the center. The former difficulty was overcome by building up a huge system of shores and blocks in the wake of the forward cargo port between decks. This also overcame the latter difficulty at the same time, as the chain was passed through the ports and around the various blocks of wood, etc., throwing the lead of the chain very near in line with the lead of the drags.



STEAMER DENVER AT THE SHIPYARD OF HARLAN & HOLLINGSWORTH CO.

This chain was then carried aft along the side of the ship and held in place by lashings carried up to the main deck. A man was placed at each one of these lashings to cut it loose at the proper time.

The chain was carried aft about two-thirds the length of the vessel, and some slack chain allowed along the ground before it was carried back to the drags. This was done to insure the drags taking effect just as the bow had reached the water. The jar on the boat was felt, but was not as great as was expected, owing to the parting of the chains. The main chain on the starboard side parted, and one of the branch chains on the port side, but the port main chain and the wire cables held fast. The reduction of the shock was due somewhat to these facts, and also to the decrease in the loads previously mentioned.

To show the great weight of this vessel it may be mentioned that she practically broke away, but not soon enough to cause any serious accident. All of the keel blocks but about ten had been knocked out when the excessive cracking and straining was noticed. Indeed from the time of knocking out the first keel block the boat was straining to get away. The speed of the vessel along the ways, as expected, was very great, and a cloud of smoke at the bow announced the fact that the tallow was burning. The lashings from the chain were promptly cut at the required moment, and by the time the huge hull was clear of the ground ways a commotion was noticed in the neighborhood of the drags. The spilling of one pile of pig iron, the hill-climbing feat of another, the breaking chain and the commotion following in the paths of the drags, gave evidence that an attempt was being made to stop the vessel ere she reached the other side, and the attempt was successful, and no damage amounting to anything was done.

Considerable experience was gained, however, and the experiment was a success from more than one point of view. In any future attempts along this line attention will be paid to a gradual increase of the weights of the succeeding drags. The method of constructing the drags will be along the line of the box-sled type. Wire cable should be used as the dragging agent and chain left alone, as a flaw in any one link destroys the efficiency of the entire chain.

As a means of releasing the vessel, when all ready to go into the water, the plank-sawing system was done away with and the trigger arrangement used, as shown in the figure. This arrangement has been used at these works before with considerable success, and is being used in some of the other yards in this country.

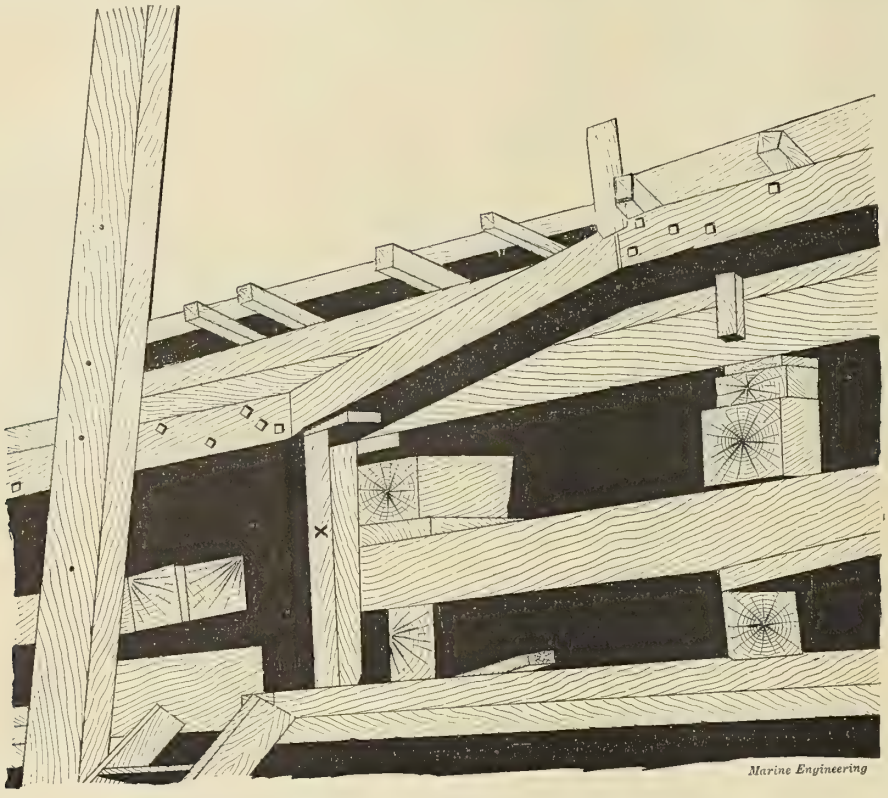
The arrangement consists of two fixed pieces of stout oak, one bolted securely to the side of the ground ways and one to the other side of the sliding ways, a slanting horizontal piece of timber between the two preventing the ship from starting. This slanting piece is beveled at each end, and is prevented from being forced out by a shoulder on the sliding ways and by a trigger piece carried vertically down from the other end to a solid block. The use of a battering-ram releases this trigger, and that in turn releases the slanting horizontal piece, the ship being then free to move. This method is very simple, and is somewhat quicker than the sawing of a plank.

The *Denver* has the following principal dimensions:

Length over all	386 ft.
Length between perpendiculars	368 "
Beam moulded	48 "
Depth to lower deck, moulded	16 "
Depth to main deck, moulded	26 "
Depth to awning deck, moulded	35
Dead weight carrying capacity on 19 feet	3,000 tons
Bunker capacity	1,260 "
Cargo capacity	250,000 cu. ft.
Speed on 19 feet mean draft	15½ knots

The specifications are up to the requirements of

Lloyd's Register of British and Foreign Shipping for 100A rating of the awning deck type. There are three decks continuous from stem to stern, all three decks to be completely plated fore and aft. Some of the special features of this ship are the large cargo ports and deck hatches for quickly handling cargo, and much reinforcing was made necessary to bring the strength of the boat in the way of hatches up to the requirements. The keel is of the flat plate type, 36 inches wide and 18-20 inch thick, reduced to 14-20 at ends. It is doubled for half length with 14-20 inch plates. Butts of keel and doubling plates have double riveted butt straps. The stem is of the best hammered scrap iron 11 by 3 inches; bottom part is of cast steel made to conform to keel plates. The stern frame is of cast steel, with gudgeons and stoppers cast on. An extension stock, also of cast steel, is carried up to awning deck for attachment to the steam tiller. There are four pintles, 4 3-4 inches diameter, and heel. The rudder frame is also of cast steel, with coupling at upper end to connect with the stock. The rudder is of the single plate type, and the weight is carried on bearing on main deck with stuffing boxes. The center continuous plate keelson 48 inches deep by 14-20 inch for half-length amidships, reduced to 11-20 inch at the ends, extends 18 inches above top of floors and has double angles 6 1-2 by 4 1-2 by 10-20 inches on upper edge, with 14 by 14-20 inches rider plates. This is connected to the floor stringers and keel plates by 6 1-2 by 4 1-2 by 10-20 inch angles. The frames for 3-5 lengths amidships are 7 1-2 by 3 1-2 by 9-20 inch angles. These extend in one piece from center keelson to awning deck stringer plates, and are spaced 25-inch centers. Reverse frames are on every floor, carried up to main deck, double under engines and boilers up to turn of bilge. They are 4 1-2 by 6 1-2 by 9-20 inch, all fore and aft, but 11-20 inch under boiler space. The floors are of 30 by 10-20 inch plates for 3-5 lengths amidships, reduced to 8-20 at ends. In engine room they are 11-20 inch thick and in boiler-room 12-20 inch. They are connected to center keelson by double angles 4 1-2 by 3 1-2 by 9-20 inches. Keelsons are carried all fore and aft, ending in efficient breast hooks and are intercostal between floors 9-20 inch thick. They extend above the floor and are secured between bulb angles 7 1-2 by 4 1-2 by 10-20 inches. There are two hold stringers on each side consisting of 15 by 10-20 inch plates connected to shell and frames by angles 3 1-2 by 4 1-2 by 9-20 inches and faced with 6 by 3 1-2 by 9-20 inch angles. Web frames are spaced every eight frames, and consist of 10-20 inch plates faced with double angles 4 1-2 by 3 1-2 by 9-20 inches. At the junction of stringer and web frames a diamond plate is riveted to angles on face of stringer and web frames. Extra web frames are fitted at cargo ports with half round on inner edges. In the engine room the web frames are spaced three frames apart.

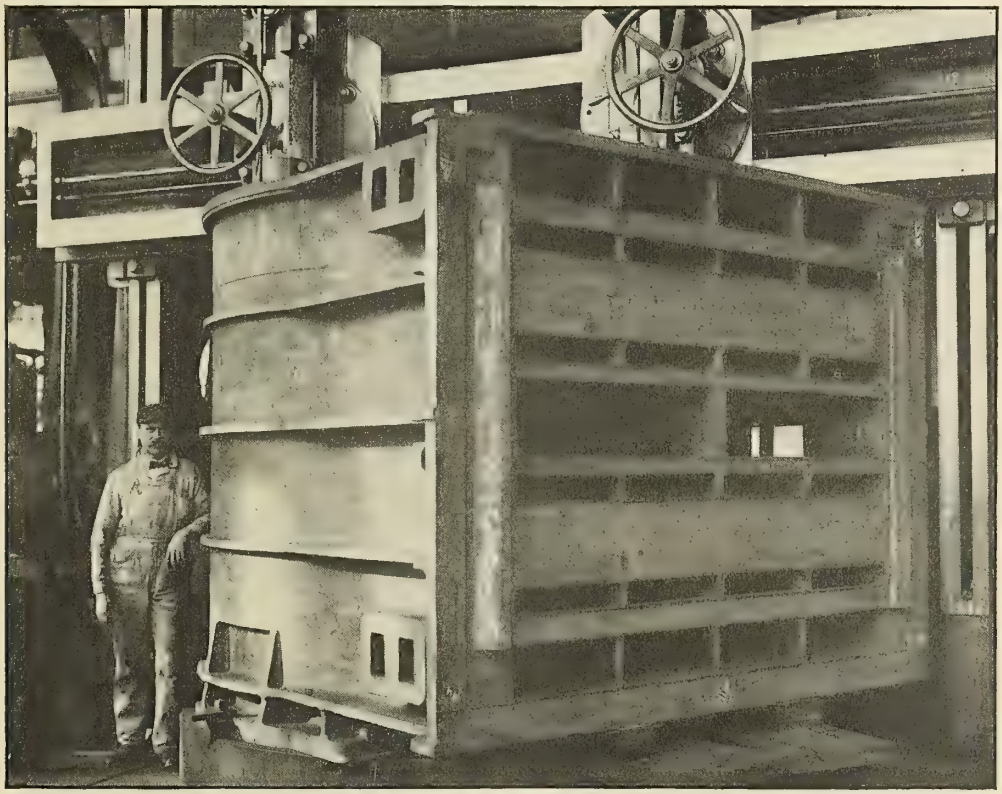


TRIGGER ARRANGEMENT OF LAUNCHING WAYS, TRIGGER AT X.

The awning deck is of steel all fore and aft. Stringer plates are 50 by 9-20 inches for half length, reduced to 38 by 8-20 inches at ends, butt strapped and double riveted. The stringer angle is 4 by 4 by 9-20 inches, and waterway angle 3 by 3 1-2 by 6-20 inches. The beams, 9 by 3 1-2 by 10-20 inch bulb angles are on alternate frames. Beams at ends and in way of hatches are increased in size. The beams are connected to

frames by bracket plates 24 by 25 by 10-20 inches, diagonal edge flanged. Tie plates are 10 by 10-20 inches. In the way of athwartship hatches the stringer plate is portable with suitable connections to preserve continuity of strength. The camber of the awning deck is 12 inches. The main deck is of steel all fore and aft, 8-20 inch for half length and 7-20 inch at ends, with single riveted laps, double riveted lapped butts. The stringer plate is 59 by 12-20 inches for half length amidships, reduced to 45 by 9-20 inches at ends, with treble riveted butt straps amidships and double riveted at ends. The stringer angle and clips to shell are 4 by 4 by 9-20 inches, and the waterway angle is 3 by 3 1-2 by 6-20 inches. The beams are placed on alternate frames and are 12 by 3 5-8 by 10-20 inch, stringer plates and angles at ends of beams. An extra girder is worked in to prevent bellowsing.

There is a center row of stanchions on every beam amidships with quarter stanchions on alternate beams at ends. The stanchions in the hold are 3 3-4 inches diameter and 3 inches in upper 'tween decks. The garboard strakes and plating are 36 inches wide by 14-20 inches half length amidships, reduced to 13-20 inches at ends. The bottom, bilge and side inside strakes are 12-20 inch for half length amidships, reduced to 9-20-inch at ends. Outer strakes are 13-20-inch, reduced to 10-20. The awning deck sheer strake is 7-20 inch; the main deck sheer strake is 44 by 14-20 inches, reduced to 11-20. The butts of plating are lapped up to main deck sheer strake. Compensat-



LOW PRESSURE CYLINDER OF ENGINE ON STEAMER DENVER.

channels connected to frames by plates 33 by 27 by 10-20 inches, with diagonal edges flanged. The camber of the main deck is also 12 inches. The lower deck is of steel all fore and aft, 8-20-inch for half length and 7-20-inch at ends. The laps are single riveted, and the butts are lapped and double riveted. The stringer plate is 50 by 9-20 inches amidships, reduced to 38 by 8-20 inches at ends. The butts are strapped and treble riveted amidships and double at ends. Stringer angles and clips to shell are 4 by 4 by 9-20 inches, and the waterway angle is 3 by 3 1-2 by 6-20. The beams are on alternate frames of same section as those of the main deck. They are connected to frames by plates 30 by 33 by 10-20 inches, with diagonal edges flanged. The camber of this deck is 10 inches. There is an orlop deck in the forehold with beams 12 by 3 5-8 by 10-20 inch channels on alternate frames with ing plates are worked around all openings on ship's sides. The mouldings are of 3 inch half round section. The fender extends for 200 feet on each side, and is of channel section filled with pitch.

There are six water-tight bulkheads all extending to the main deck, of plating 8-20 and 7-20 inches, stiffened by vertical angles 6 by 3 1-2 by 10-20 inches spaced 24 inches, and by horizontal angles 8 1-2 by 3 by 12-20 inches spaced 48 inches and well bracketed. All bulkheads over 45 feet wide have two vertical webs at middle line consisting of 12-inch channels; those over 35 feet wide have one 12-inch channel. The bulkheads are connected to the shell by 6 by 3 1-2 by 10-20 inch double angles. The forward and after peaks are arranged for carrying water ballast. The bunker bulkheads are of 7-20 inch plates with vertical stiffeners 4 1-2 by 3 1-2 by 9-20 inches spaced 30 inches. The

shaft alley is made of 7-20 inch plates increased to 9-20 inches under hatches and stiffened by angles.

The cargo hatches in the awning deck are of the following sizes: No. 1, 12 by 14 feet; No. 4, 10 by 15 feet, to be fitted with steel hinged covers; No. 2 is 18 feet long and No. 3 is 15 feet long, and both extend from side to side, leaving the ship entirely open in the way of hatches. The coamings stand 18 inches above the deck. The hatches on the main deck are: No. 1, 12 by 14 feet; No. 2, 18 by 20 feet; No. 3, 15 by 15 feet; No. 4, 10 by 15 feet. All of these have steel covers. There are also two blind hatches 4 by 5 feet, and one 9 by 9 feet. The covers of the blind hatches are of steel and are made water-tight. The hatches on the lower deck are of the same dimensions as those of the main deck, but have wooden covers. There is but one hatch in the orlop deck 12 by 14 feet.

The engine casing extends from the lower deck to the top of the houses around stack. The engine foundation is of 1-inch plates riveted to raised floors. The boilers are held in place by saddles 12-20 inch thick and are placed 15 inches above floors. For a distance of 150 feet amidships bilge keels are fitted, made of 15 by 15 by 15-20 inch plates with double angles.

STERN OF MALLORY STEAMER DENVER.

The numerous side ports made in two parts are hinged fore and aft. The location of these and approximate sizes can be learned by referring to the illustration on page 379. There are two coal ports on each side the lower 'tween decks. The bottom of the vessel is cemented to the top of frames to the lower turn of bilge. The awning deck houses are of steel plates 5-20 inch thick, stiffened by 3 1-2 by 3 by 6-20 inch angles spaced 36 inch centers. The forward house contains two hoisters and space for fire-proof storage;

baggage and package room; the midship house contains first-class passenger accommodations; in the house at the mainmast are two hoisters; the after-house contains steerage accommodations and steering gear. The promenade deck house is also of steel, 5-20 inch sides and 3 1-2 by 3 by 7-20 inch beams.

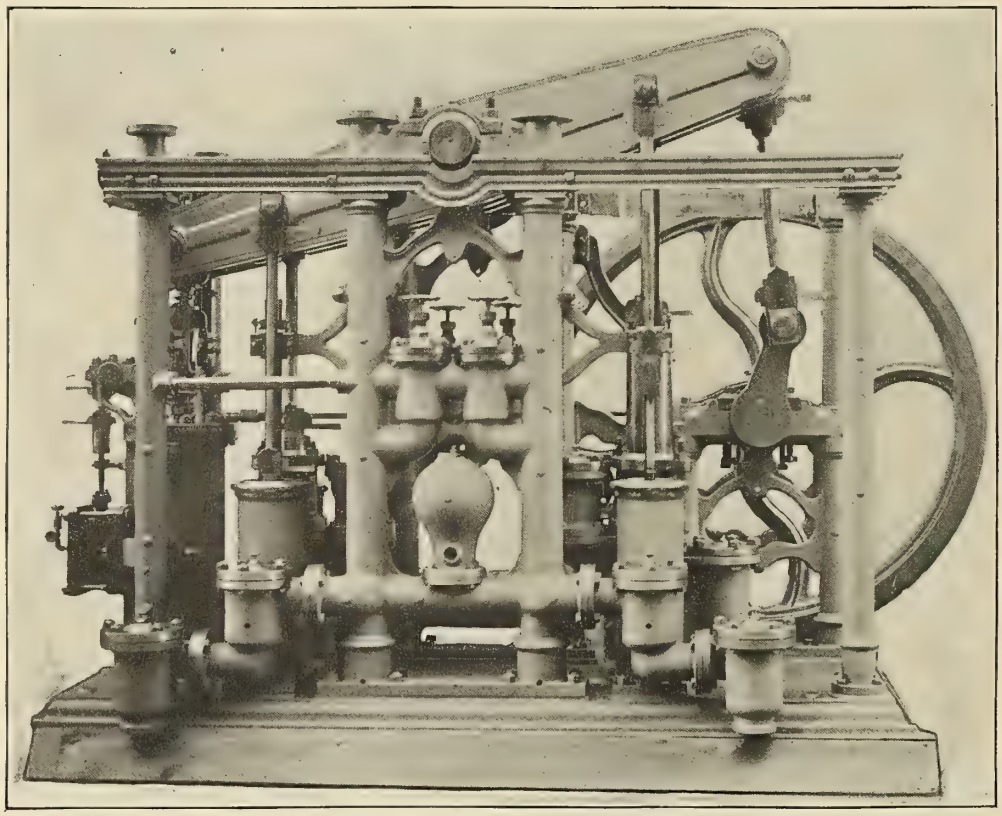
There are two steel pole masts arranged to ventilate holds and fitted with composition ventilating trucks. Each mast has four derricks and has a leg-of-mutton rig. The equipment must pass the United States In-

SHIPPING A BOILER ON THE STEAMER DENVER.

spection Laws. There is one bower anchor weighing 54 1-2 hundred weight, two 50 1-2 hundred weight stockless anchors, one 12 3-4 hundred weight stream anchor and one 6 1-2 hundred weight kedge anchor. The required amount of steel wire, chain and Manila rope are supplied. The steam windlass is located on the awning deck, two dock capstans are aft and the vessel has steam steering gear. There are two steam fire pumps located on the awning deck and five cargo hoisting engines.

The machinery of the *Denver* consists of a direct acting triple expansion inverted engine, with cylinders 33 inches, 54 inches and 87 inches diameter and 54 inches stroke. The housings, front and back, are cast iron, the back one embracing the condenser. The high pressure cylinder is fitted with one piston valve, the intermediate with two piston valves and the low pressure has a double ported slide valve. The cylinders, cylinder heads and pistons are of cast iron. The piston rods, connecting rods, crossheads and valve rods are of forged steel. The crossheads have cast iron shoes fitted with Parson's white brass. The guides are bolted to the front and back housing, and the valve gear is of the Stephenson link motion type. The crank-shaft is in three interchangeable pieces, and 1-2 inch larger in diameter than called for by Lloyds. The thrust and tunnel shafts are 1-4 inch above requirements, and the propeller shaft is of the shortest possible length and fitted with composite sleeves 3-4 inch in thickness. All shafting is of forged steel. The thrust block has nine horseshoe collars of cast iron lined with Parson's white metal. The bed-plates are of cast iron, box form. The cast iron condenser contains about 8,300 feet of cooling surface on

the 3-4 inch by 18 B. W. G. solid brass tin tubes. The tubes are arranged in two sections, the water passing through the top and returning through the bottom. A complete water service is arranged for circulating water through the guides to each main bearing, to each pair of excentric straps, thrust bearing and each line shaft bearing. The air pump is independent of the main engine and is of the Blake type. There are two 12-inch centrifugal pumps worked by separate engines for circulating water through the condenser. There are two Blake feed pumps, one vertical duplex bilge pump, duplex fire pump, water service pump and sanitary pump. An evaporator of 30 tons capacity, an auxiliary condenser and feed water heater are also installed.



DOUBLE-ACTING FORCE PUMP, COMMONLY CALLED THE DOCTOR.

Steam is supplied by four Scotch type boilers each 16 feet 3 inches diameter and 11 feet 6 inches long, built for a working pressure of 180 pounds. In each boiler are four Morison suspension furnaces of 40 inches inside diameter, each furnace having a separate combustion chamber. The boiler tubes are 2 1-2 inches diameter of welded iron. The plain tubes are rolled in tightly and beaded over at both ends. The stay tubes are screwed into both plates, the front ends being enlarged. The boilers are to be worked with Howden draft. The donkey boiler is 9 feet diameter and 9 feet 3 inches long, working at 180 pounds pressure.

The accompanying illustrations of machinery and of the hull of the *Denver* give a general idea of the class of work and type of vessel. The Mallory Line expects to place the ship in commission for the fall service between New York and Galveston.

SHALLOW WATER NAVIGATION.

BY WILLIAM H. CRAWFORD, JR.

While our seagoing merchant marine has been developed to such a degree that we are inclined to look upon it as perfection in the field of marine work, the steam craft for inland or river navigation claim little or no attention. When we see the cumbersome stern-wheeled boats pushing their way along in the midst of a big fleet of coal barges, the inclination is natural to rank them among the antiquated examples of early engineering, whereas they really represent the highest type of development possible under the existing circumstances. The fact of the matter is that both branches of marine work have advanced with equal energy, the only difference being that in one case, the practical value and the cost of construction have been about the only limits to development, while in the other, restrictions of length, breadth, depth and height have figured as well. No expansion beyond these lines is possible, neither are any radical departures from existing features of construction likely to take place in the near future.

The popular idea, as illustrated by the story told of a Mississippi river boatman, who, when asked how much steam he carried, replied that he really couldn't tell, inasmuch as his gauge only ran up to 130 pounds, should not be permitted to apply to the whole field as a rule. There are of course some instances where careless primitive customs exist, but as a whole there is science in the construction and development of these boats, and marvelous skill shown in their handling. The numerous ingenious appliances which, though

striking at once as illustrations of the old saying that necessity is the mother of invention, are also as commendable and as well worthy of study as any of the more familiar deep sea engineering subjects.

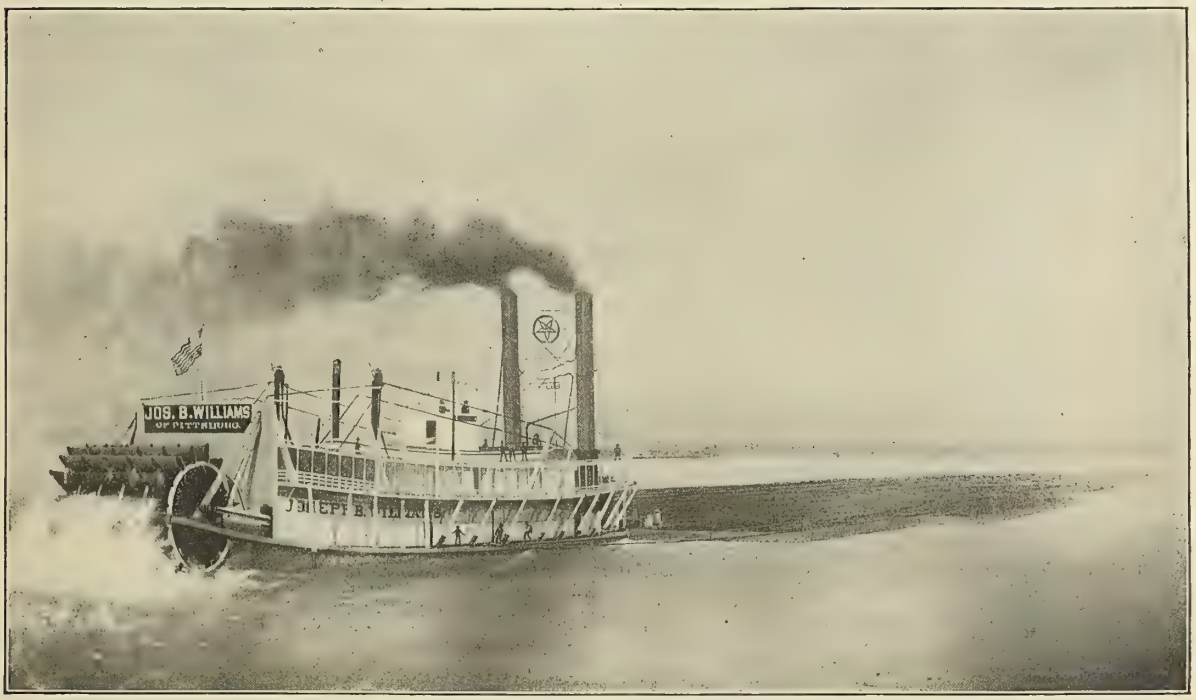
Considering the limitations of depth, length, breadth and height; it is well known that our rivers are for the most part shallow. Take for example the Ohio from Pittsburg to Louisville, where the average running depth is 4 feet, and from Louisville to New Orleans, average depth about 10 feet. The shallowest part of the waterway is the outside limit for draft of vessels, and even the narrow margin that exists would not be as much as it is were it not for the use of many dams in the river. With the dams must come locks, and hence more restrictions to development, beyond the width and length of the smallest lock.

we find the native products being here assembled, turned into marketable form, and floated away on the Ohio river to various consumers.

It may be imagined that the railroad has, of recent years, come to supplant this traffic; whereas the fact is that the navigation of the inland rivers is on a steady increase, and development in this direction is as rapid as the more noticeable growth in other lines.

There is the *J. B. Finley*, for example, 211 feet long, 54 feet wide, and of 2,400 horse power, with compound engines of cylinder diameters H. P. 21 inches, and L. P. 44 inches, and a stroke of 9 feet. The cost of this boat was about $100,000, and it is claimed that under the best of conditions she can handle sixty coal barges in one tow.

I beg to quote from a Pittsburg paper under date of



THE STEAMBOAT JOS. B. WILLIAMS PUSHING A TOW.

Bridges span the rivers at many points and restrict growth beyond a certain height. The more modern of these structures were thrown across at such an altitude that they are far out of the way of navigation, but in earlier times many expensive bridges were built with but little allowance beyond that considered necessary for the existing conditions. This allowance has long ago been caught up with, and further development blocked in that direction.

The Pittsburg territory affords an excellent example by reason of its commercial importance. Before the days of railroading, the Allegheny river was used to float rafts down from a great timber district, the Monongahela river to float coal down from a great coal field, while iron and other products came from both directions. These streams met at the point where Pittsburg now stands, and formed a great waterway that offered commercial communication with the surrounding country and the outside world. Hence

June 19, 1900, to show what an important thing it is to have boats that are easily handled, and how well they really accomplish the work required of them:—

"The manner in which the coal fleet was started south on Monday caused many expressions of approval. There was not a hitch of any kind in the program. Rivermen say that it shows what can be done in the way of avoiding accidents when a big fleet is started out under systematic management. The boats that left were all below New Cumberland and Yellow Creek, 54 miles from here, before breakfast, and the *Wm. G. Horner* was the only boat (out of some fifty) to meet with an accident, leaving a barge on the bar at Baker's Island; but it can be saved.

"The total shipment up until noon *approximated* 6,872,000 *bushels of coal.* The shipment thus far, counting what went on Saturday, *amounts to about* 8,000,000 *bushels.*

"The rise has taken every towboat of importance

out, and fifty of them are now plowing the yellow waters of the Ohio in a mad race for the southern markets."

The barges constituting one tow, are lashed together, usually, four or five abreast, and one towboat can handle from eight to sixteen barges. The steamer is lashed in behind the tow and with its broad, powerful stern wheel, works the raft in between bridge abutments and around narrow bends in the river by a vigorous backing up and running ahead until the acres of floating coal are pointed in the right direction. Three rudders are used, one amidships and one on each counter.

The average relationship of cylinder diameter to stroke is 18 1-2 inches diameter to 7-foot stroke, or 20 inches diameter to 6-foot stroke. It is still an open question whether the best results are obtained by increasing the stroke and cutting down cylinder diameter, or shortening the stroke and giving the cylinders more diameter. Coal consumption is practically no object. This is seen from the fact that only within the past year have compound engines appeared. The boat is usually in the midst of acres of available coal, and if not, a barge is lashed alongside as a tender, so no bunkers are necessary. One peculiar fact illustrating the very extravagant ideas in this trade, is that most of the coal barges make but one trip from the mines to the southern markets. There they are left to be broken up if not already dilapidated from the voyage down, and the towboat returns light. It is usually considered cheaper and easier to make new barges for each shipment than to bring back the "empties."

The boilers used are of one standard type of construction—the old cylindrical flue boiler, with furnace built in, under the shell. They are always arranged in groups of three, and are strong and simple, but exceedingly expensive to operate. Their average size would be about 26 feet long by 38 inches to 40 inches diameter, with two flues running the entire length of the shell and about 14 inches diameter. The grate area figures about 15 square feet, and when compared to the heating surface gives a ratio of about 1 to 21.5.

The steam has to pass from the front end of the boat to the extreme rear in order to reach the engines, so that the loss due to condensation is considerable. But with all these extravagant practices, the boats pay big profits and do their work so well that it is not likely that we shall see in the near future any radical departures from the existing features of construction.

SMALL STERN WHEEL STEAMBOAT LOMA.

AMERICAN SCHOOLS OF MARINE ENGINEERING AND NAVAL ARCHITECTURE.

University of Michigan, Ann Arbor, Mich.

The advancement of the ship building industry that has taken place within the past few years, has led to the demand for properly trained men in this branch of the engineering profession. Ten years ago few if any of the universities or technical schools offered complete courses of instructions in naval architecture and marine engineering, with the result that those who wished to study these subjects were compelled to seek other schools in Europe.

Now, however, these subjects are taught at one or two of the leading universities and engineering schools, and amongst the latest to inaugurate a course in the above is the University of Michigan.

The University of Michigan, which is situated near Detroit, has always been the metropolitan university of the middle West. In point of number of students it stands second in the list of universities of America.

The university was founded in March, 1837, and in the Act of Legislature for that year provision was made, amongst others, for a professorship of civil engineering and architecture. In this country, therefore, this university was one of the first to provide for instruction in engineering. The present engineering department grew out of the scientific course, and in 1853 a professor of civil engineering and physics was appointed. The first degrees in civil engineering were conferred in 1860, and about ten years later, owing to the growth of the department, three assistants were provided, one of whom was Professor Greene, the present dean of the faculty.

In 1881, at the request of the board of regents, a graduate of Annapolis was detailed as instructor in

mechanical engineering, and four years later became professor in this subject. Professor Cooley, the present head of the mechanical engineering department, was chosen for this position.

A department of electrical engineering followed in 1886, and some time later courses in chemical engineering were started.

Since its inauguration the number of students has greatly increased, and to keep pace with this and also

GENERAL VIEW OF CAMPUS, UNIVERSITY OF MICHIGAN.

with the development of the various branches of study, new buildings have been continually added. Both the practical and theoretical sides of the various subjects receive an equal amount of attention, and in connection with the mechanical engineering course instruction is given in foundry work, smith work, pattern making, machine work, etc. The various shops are fitted with the most modern machine tools, and during his course of study the student performs a certain

ENGINEERING BUILDING.

amount of work with each machine. Some of the machines have been designed and built entirely by students.

The course in mechanical engineering also includes laboratory practice, and for this work a general laboratory is provided which contains all the necessary appliances for conducting tests of all kinds.

During the past few years a course in marine engineering has been given, and owing to the interest taken in this the regents decided last year to start a special course which should include both naval architecture and marine engineering. Professor H. C. Sadler being appointed to take charge of this work.

Professor Sadler received his early training on the Clyde, and is a graduate of Glasgow University in naval architecture and marine engineering. After some years in practical work in the Clyde ship yards, he was appointed assistant professor of naval architecture at his alma mater. While in this position he was associated with Professor Biles; and last year, on the invitation of the board of regents of the University of Michigan, accepted the call to inaugurate the course of naval architecture and marine engineering.

MOULD LOFT.

COURSE OF STUDY.

It is a universally recognized fact that the naval architect and marine engineer should have a good training in general engineering before specializing in their various branches. With this end in view the courses of instruction in these subjects have been arranged as post-graduate ones. In the second half of his fourth year the student may take up the first two courses, which consist of the preliminary parts of the subject, and during the fifth year his whole time is devoted to naval architecture and marine engineering.

The general course of study is comprised of lec-

tures, recitations and class work, and practical work in drawing, machine shops, etc. For graduation purposes a student is required to have at least one hundred and thirty hours of credit. An hour of credit is equivalent to the performance of one exercise per week per semester. To obtain one hour of credit in the practical courses requires an attendance of from three to four hours of actual time.

The course of general engineering followed by those who intend to specialize in marine engineering and naval architecture is as follows:—

First year: First semester,	French or German, English, Mathematics, Drawing, Shop practice.
Second semester,	French or German, Physics, Mathematics, Drawing, Shop practice.
Second year: First semester,	French or German, Physics, Mathematics, Chemistry, Shop practice.
Second semester,	French or German, English, Mathematics, Physics, Mechanical engineering, Shop practice.
Third year: First semester,	French or German, Mathematics, Chemistry, Mechanical engineering, Shop practice.
Second semester,	Civil engineering, Mechanical engineering, Electrical engineering,
Fourth year: First semester,	Metallurgy, Surveying, Civil engineering. Mechanical engineering.
Second semester,	Mechanical engineering, Naval architecture and marine engineering, Thesis.

Under the general heading of mechanical engineering is included laboratory and drawing office work. Having completed the above courses a student is given the degree of Bachelor of Science in Engineering. His fifth year is then devoted almost entirely to the study

DRAFTING ROOM, SCHOOL OF NAVAL ARCHITECTURE, UNIVERSITY OF MICHIGAN.

of naval architecture and marine engineering. The courses in these subjects include the following:—

Ship Calculations: Methods of laying off and fairing lines, rules for determination of areas, etc., displacement, centers of buoyancy, metacenters, change of trim, cargo capacity, launching, etc.

Strength of Ships: Discussion of various classification societies' rules, determination of bending moment, and stresses on structure in still water and in waves, strength of riveted joints, transverse strength, stresses due to docking, etc.

Stability of Ships: Initial stability, stability curves, cross curves and methods of determining the same, dynamical stability, surfaces of buoyancy, flotation, etc. Rolling of ships resisted and unresisted, in still water and in waves, methods of reducing rolling, etc.

Resistance and Propulsion of Ships: Wave eddy and surface friction resistances, stream line theory, Froude's law of comparison, trial trips, distribution of power, trochoidal wave theory. Propulsion by sails, paddles, jet propellers and screws. Efficiencies of various propellers, propeller designs, etc.

Ship Design: Discussion of dimensions and form, methods of obtaining lines, estimates of weights, general arrangements, structural arrangements, etc.

Practical Shipbuilding: Arrangements of ship yards, methods of work, preparation of working plans, ordering material, pumping and ventilation, specifications and estimates.

Marine Engineering: Types of boilers, structural details, boiler design, fuels and combustion, forced draught, etc. Marine engines, arrangement and ratios of cylinders, structural details, general design of various types, auxiliary machinery, weight and space occupied, methods of balancing, etc.

Drawing and design: In naval architecture a set of lines are first faired in the drawing office and afterwards in the mold loft. All the general calculations of displacement, centers of buoyancy, etc., are then performed and curves plotted. The work also includes the calculation of capacities, change of trim due to flooding, launching calculations, preparation of midship section, determination of curves of weight, buoyancy, steering forces and bending moments; calculation of stresses, curves of stability, etc. Later a design is undertaken and all calculations connected therewith performed. All the general and structural plans are made, together with an order form and specification.

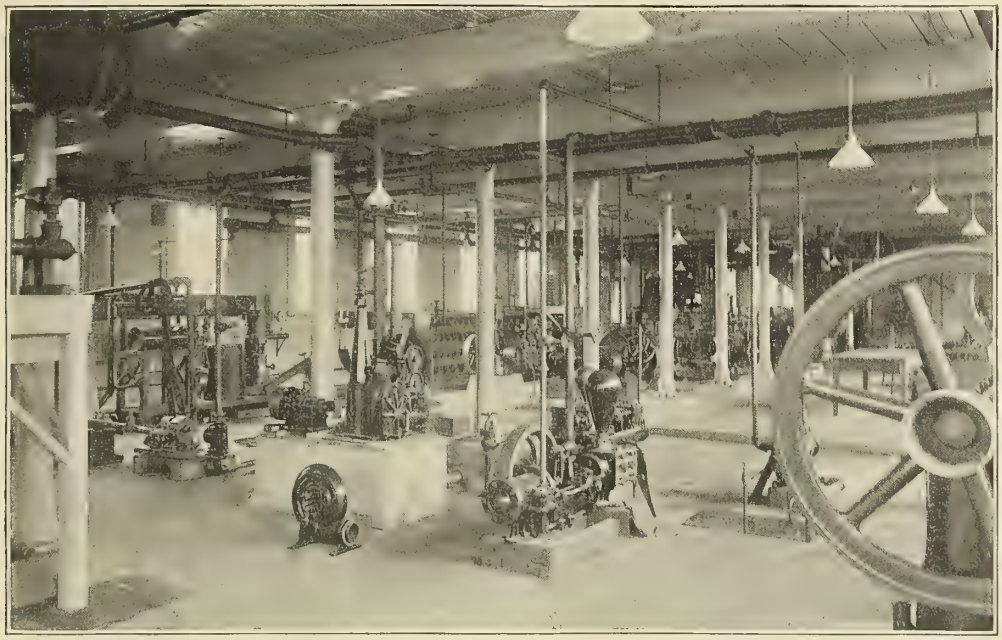
In marine engineering a design of a marine boiler with all details is first undertaken, and all the necessary calculations connected therewith performed; and later the design of a marine engine with detail plans of the various parts.

Visits of Inspection: The University of Michigan is very happily situated with regard to engineering and shipbuilding works. It is within easy distance of Detroit, Chicago, Toledo, Cleveland and other large engineering centers. As often as practicable visits are made to various works, and the students are required to make reports upon the same. During the spring vacation a tour is made which usually embraces the principal engineering centers in the East.

Equipment: The school is well equipped with all necessary instruments such as planimeters integrators, slide rules, etc., and special attention is paid to the use of these. There are also numerous blue prints of various vessels, engines and boilers, to which the student may refer. Copies of various classification societies' rules are also at hand for the use of students. The library contains all the principal works on engineering and naval architecture, together with the various current periodicals and transactions of the various engineering societies.

The drawing office and mold loft are large, airy rooms, and are provided with all the necessary fittings, such as weights, battens, curves, etc.

Facilities for Outside Students: In order to suit the convenience of graduates of other institutions or others who may wish to take up the study of naval architecture and marine engineering, and who have had the necessary training, the courses are so arranged that they may be completed in one year's residence. Such students devote the whole of their time to these subjects. The college year extends from the last week in September to the second week in June, with holidays at Christmas and Easter.



ENGINEERING LABORATORY, UNIVERSITY OF MICHIGAN.

Expenses: The tuition fees consist of a matriculation fee of $25 and an annual fee of $45. The students supply themselves with drawing instruments and paper, but all other necessities are provided by the University. The cost of living at Ann Arbor varies from $4 to $6 per week for board and lodging.

M. S. Dollar Sold.—The steamer *M. S. Dollar*, the first ship built by the New York Shipbuilding Co., has been sold to Pittsburg capitalists, and will be converted into a tank steamer for carying oil.

Marine Engineering

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

WE are glad to be able to call attention to the first of the series of articles which we publish in another column, entitled "*The Professor on Shipboard.*" The author is an engineer well qualified, both by experience and theoretical training, to appreciate at their proper relative values the theoretical and practical sides of the profession, and if we are not mistaken in the course of articles the "Professor" will learn much of the practical side of which he has been hitherto ignorant, while, in turn, he will be able to give valuable suggestions and much useful instruction drawn from his studies and somewhat different training in the same field. We believe that these articles will be found of interest and value to all engineers, no matter in what special part of the field they find their own personal work.

What features constitute the ideal battleship? This is a problem which is continually receiving new solutions according to the information at the disposal of the designer, and to the way in which such information is weighed and the relative weight given to the various items. The present two designs before the Secretary of the Navy furnish an interesting instance of this diversity of opinion with the same information at hand. The majority design, which is recommended by the Chiefs of the Bureaus of Construction, of Engineering and of Ordnance involves as the essential features of its armament four 12-inch guns in two turrets protected by 10-inch armor; twenty 7-inch rapid-fire guns protected by 7-inch armor, and twenty 3-inch rapid-firers behind 2-inch armor. The superimposed turret, about which there has been so much controversy, is eliminated from this design, and the 12-inch guns are mounted in pairs in turrets, while the 7-inch guns are mounted separately, 4 on the main deck with the 12-inch guns, and 16 on a gun deck below.

The minority design, presented by the Chief of the Bureau of Equipment, shows four 12-inch guns, twelve 8-inch guns, twelve 6-inch guns and eight 3-inch guns. The 12-inch guns are placed in pairs in turrets, each with two 8-inch guns in superimposed turrets above. The other 8-inch guns are carried two each in four turrets, as seen on the *Oregon* class. The 6-inch guns are carried in broadside on the gun deck.

Aside from the armament, there are few points of vital difference in the two designs. The design presented by the majority report calls for a displacement of 16,900 tons, and that by the minority for 17,200 tons. The I. H. P. in each case will be about 20,000, and the speed about 19 knots.

Without entering into the many questions which these two designs present, we shall here note simply a few points regarding the 7-inch gun as a new factor in naval armaments. Its chief advantages seem to be these: Since the improvements in Krupp armor the 8-inch gun is clearly outclassed by turret and all of the heavier belt armor, for the piercing of which the guns of 10 and 12-inch caliber are required. The field of usefulness of the 8-inch gun is therefore restricted to the more lightly armored parts, and for these it seems unnecessarily heavy, with the accompanying relative slowness of fire. The 6-inch gun is admirably adapted for work against unarmored and lightly armored parts, and has a relatively high rapidity of fire, but in the opinion of many is not quite heavy enough for the all-around work which the gun of intermediate caliber is likely to be called on to do. From these considerations we may be naturally led to consider the suitability of a

7-inch caliber, and while in our own service we have had no experience, it would appear that its qualities will be such as to cover well at least a large part of the field assigned to the intermediate caliber gun. The shell is about two-thirds the weight of the 8-inch, but a rapidity of fire nearly double is expected, so that a greater muzzle energy per minute would be developed with the lighter gun. Again comparing the muzzle energy of the 7-inch gun with a velocity of 3,000 f. s. with that of the older type of 8-inch with muzzle velocity of 2,000 f. s., we find the energy for the modern 7-inch gun about double that of the older 8-inch. Having in view, therefore, its power and its expected speed of fire of 2.5 rounds per minute, it is evident that this gun possesses many features which will enable it to serve acceptably as a support for the main battery of 12-inch guns.

At best, however, we must admit that warship design and armament is very largely a matter of opinion, and that actual trial only can furnish demonstration. The chief trouble is that no opportunity comes of making the trial, or at least for making it under proper conditions, so that we go on from year to year building what we think is best, but far from having the assurance of the fact which we should naturally wish. We may take comfort in the thought, however, that other navies are in the same condition, and that no one Power is likely to get very far away from the main features accepted by the general consensus of opinion among the others. In the meantime the development of many types and varieties considered as part of the experiment is to be commended, for in no other way are we likely to gain any information which may be of aid in furthering the solution of the problem of warship design. It is certain, furthermore, that there never will be an accepted standard type. There will be always room for differences of opinion, and always room for new and untried combinations. Either of the designs proposed would make a most formidable battleship, but we should prefer to see the design of the majority report adopted, as it doubtless will be, both for its own intrinsic features, and because it presents a more pronounced departure from the types which we now have, either built or under construction, and thus will be the more interesting and valuable as an experiment in the further development of the problem.

The description of the machinery of the *Inchmarlo*, and especially of the boilers, calls attention to the use of superheated steam in marine practice. In stationary engine practice in Continental Europe such advances have been made in the use of superheated steam that no modern installation with pretense to economy would be considered complete without it. The leading Continental builders of steam machinery are now coming to consider superheated steam almost as a matter of course, and many of them have developed their own special systems and types of superheaters and engines for its use.

In marine engineering the introduction of superheated steam has been much slower, and, in fact, it can hardly be said to have at present any standing as a feature of modern marine practice. Still, the experience gained in stationary practice has shown that under proper conditions its use can be made a mechanical success, and that a pronounced gain in economy may be thereby obtained. The reason for the slowness of its introduction into marine practice is, however, not far to seek. Added weight and complexity of equipment are of course required, and the balance between such weight taken from the cargo capacity and the saving in weight of coal, together with that between the interest on the added investment and the saving in cost of coal, must be very carefully made before we can be sure that it will be of advantage to adopt such means for greater economy. In the case of the *Inchmarlo* these questions were doubtless carefully considered, and for a ship of this type, making long voyages and under the necessity of buying coal in foreign ports at high prices, it seems very clear that there is a good chance for the economical use of superheated steam. On the other hand, in warship practice and especially where the utmost must be obtained per pound of machinery, or where the trip is short or fuel is moderate in price, its use will be of more doubtful value. With our present information it is hard to say in the typical mercantile case whether the use of superheated steam is or is not likely to prove economical. What is needed is more experience, and it is to be hoped that the example of the *Inchmarlo* may be followed by others until the proper limitations for superheated steam in marine practice may be determined for our future guidance.

THE CONTEST FOR THE PRIZES.

All articles intended for competition for the two prizes of $15 and $10 each, mentioned in our advertising pages, must be sent in promptly, as the contest will close on December 31.

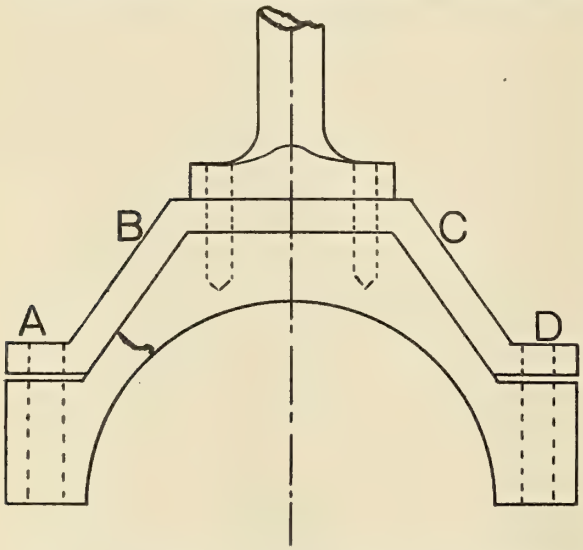
All articles published will be paid for at the regular rates. The best and the next best will draw the prizes in addition.

Repairing a Broken Excentric Strap.

A few years ago I was serving as chief engineer of the *Chesdale*, a 4,000-ton freighter plying between Liverpool and West Indian ports. We had a triple expansion engine of about 1,200 I. H. P., and the engineers took great pride in their department, and we all did our best to maintain everything in a condition which we need not be ashamed of.

One evening, about 7.30, as I was enjoying a comfor table smoke, I noticed suddenly a slowing down of the engine, followed by a stop. No matter where an engineer is on board ship, he is never out of touch with his engine. The jar and vibration follow him everywhere and give him continual tidings of the state of affairs below the gratings. The instant the engine slowed down, therefore, I detected the change and was keenly watching for the next development. Scarcely had she stopped when I was on my way below, and at the door of the engine room met an oiler sent by the engineer of the watch to inform me that the main high pressure go-ahead excentric strap had broken off short. Without waiting to question regarding details, I hastened below to examine the nature and extent of the trouble and to make plans for its repair.

Here I may digress a moment to recommend to every young engineer the practice of dealing with imaginary breakdowns and their repair. I had followed this practice since I was a third assistant, and there was hardly a break liable to occur in ordinary



practice which I had not studied over and thought out some way of making a repair. Of course one cannot expect in this way to cover all the combinations and possibilities which may arise, but very much may be done, and the young engineer will find the practice of the very greatest value as an exercise, and it will surely aid in preparing him for emergencies such as are liable to occur at any time in the experience of the seagoing engineer.

On reaching the scene of the trouble, I soon saw that the break was one for which I had a long time before thought out a good repair, though I had never before been brought actually face to face with the necessity of using it.

The nature of the break and of the repair will be readily understood from the cut. A bar of flat iron of about the same width as the strap was bent as shown, the measurements being so taken as to leave a little clearance for drawing down between the ends A and D and the excentric strap lugs. By this means, when the strap bolts were put in place and the nuts screwed down, the parts were firmly bound together and the repair was complete.

It will be noticed that this mode of repair will result in lengthening the excentric rod by the thickness of the metal of the added strap. This was allowed for by shortening up the valve stem an equal amount, thus leaving the valve in the same relative position and without change in its operation.

The details of this repair include the following: Dismounting the parts, making four bends in the strap A B C D, drilling two holes for the strap bolts and two for the excentric rod studs, assembling in place and screwing down, adjusting valve stem.

The entire time required was about six and one-half hours. On starting the engine carefully the excentric strap was found to operate perfectly, and we soon increased to nearly full speed, at which we ran for about 1,400 miles to port, where permanent repairs were made.

William Carpenter.

Plugging a Boiler Tube While Under Way.

Plugging a leaky boiler tube in a Scotch boiler is not an unusual experience for engineers, especially where old boilers are used which have been overhauled for many years. When I was chief engineer on board the propeller *Prescott*, plying on the Australian coast, we had no time to lay up at the shipyard for general repairs, and for two years we were never in port for more than one day at a time. The company was shorthanded and drove the old *Prescott* year in and year out on the nightly service between Sydney and ——. Her boilers were in bad condition at the time of which I am writing, there being no less than 116 plugged tubes in the four double ended boilers. Besides this number we had replaced 63 tubes. However, though I had reported the condition at the office, the superintendent could not get the boat off for repairs on account of rush of business and the fact that even in this crippled condition she was making her time. The boilers are 14 feet 3 inches in diameter and 20 feet 6 inches long. There are two corrugated suspension furnaces 48 inches in diameter by 6 feet 8 inches long in each end of the boiler, each furnace having a separate combustion chamber. The tubes are 2 3-4 inches outside diameter.

The engineer on watch was always prepared for and expecting a tube to give out, and when this happened, as it usually did when we were under way, we stopped them up without lowering steam by driving into the

defective tube a plug of soft white pine made to fit snug and about 15 inches long. These wooden plugs were removed after the boilers were blown off upon reaching port, and replaced with the usual cast iron plugs, one at each end of the tube, drawn together by a bar of round iron with threaded ends passing through tube and plugs and drawn tight at the outside end.

One night we had been delayed on account of heavy freight, and were driving the engines at full speed, when the hissing noise of steam in the furnace of the forward starboard boiler gave notice that another tube had given way. Charlie Baxter was on watch at the time, and it did not take him long to locate about where the leak was. It came from one of three plugged tubes on the lowest tier of the nest, but as it only escaped into the combustion chamber and the outside ends were all tight, we could not tell which of the three was leaking. The leak grew worse and worse, so that soon we had to put on the salt water feed to make up the loss, and then the plates of the combustion chamber became coated with salt. If that leak was not located and stopped at once we would have to cut off the boiler, which meant reduced speed for many hours. Charlie said he was willing to go in to find that leak if I would have that fire drawn. The one fire was drawn, and the grate bars removed. Bags were laid over the bottom of the furnaces and fire wall, and Charlie crawled in, head first, to the rear of the furnace. All this time the other three furnaces were being fired as usual, and the boiler was supplying steam at the regular pressure of 90 pounds. It did not take him long to find which of the plugged tubes was leaking and to unscrew the nut so that the rod could be drawn out, and then crawl out himself. From the fire room we then drove in a wooden plug, as mentioned above, till it covered the hole in the tube. The steam expanded the soft wood so that a tight patch was made which held all right until reaching port the next morning. Charlie was pretty well used up because of his hot experience, but came around all right in a few hours. It took just half an hour to make this repair from the time the fire was drawn till it was re-lighted, and no time had been lost on the trip.

A. S. K.

Cutting Out the High Pressure Cylinder.

The accident under this name was one of many that occurred while I was first assistant engineer on the compound beam engine steamer ———, running on the Pacific. There were many bad points about the engine, and it was the unusual thing when something did not happen on the trip north or south. It was enough to make your hair stand on end to watch the bedplate of the high pressure cylinder rise and fall and bend at each stroke of the engine.

One rough night, when the steamer was pitching around rather uncomfortably, I discovered a crack in the base of the starboard crosshead guide of the high pressure cylinder. I shut down steam, had the fires drawn, and sent up word to the chief. We started to disconnect this cylinder at once. It is no light work to handle the heavy parts of a beam engine, and it is extra hard to do so when the boat is rolling and pitching. We first shored up the top exhaust and steam valves and then lashed down the lower exhaust and steam valves. The excentric rod was lashed up away from the hook. While this lighter work was being done below, men above were disconnecting the links from the walking beam. The engine was stopped with the high pressure piston at the bottom. When the links were clear we made fast the crosshead to the cylinder with several turns of heavy rope. This, together with the weight of the piston rod, crosshead and links, the chief supposed would be enough to keep the piston in place, even though the lower steam valve might leak a little.

We now had the high pressure cylinder free and acting simply as a receiver for the steam on its way through the upper steam and exhaust valves to the low pressure. Steam was reduced to 40 pounds, and five hours after the accident we were ready to go ahead with one cylinder. All went right for the first few turns, and then we saw the crosshead lift and fall a little at every turn. This motion kept growing, and before we could lash another rope around it amounted to several inches, and was caused by the steam leaking past the lower steam valve and into the clearance space below the piston. The strands of the first rope were cut almost as soon as the second was secured, and we had to keep replacing the ropes as fast as possible, until the mate brought us a few fathoms of his lightest anchor chain, for among our small stores there was not a heavy chain to be found. I have heard people in the East talk of harnessing Niagara, but I warrant none of them ever felt so uneasy over it as we did that stormy night while trying to hold down that piston.

Upon reaching port the chief at once made out a requisition for a couple of iron yokes to fit over each end of the crosshead and bolt down on the stud bolts of the cylinder head. So the second time this cylinder gave out, about a year afterwards, we were prepared for it, and after these yokes were strapped on the crosshead had no chance to break away. H. F.

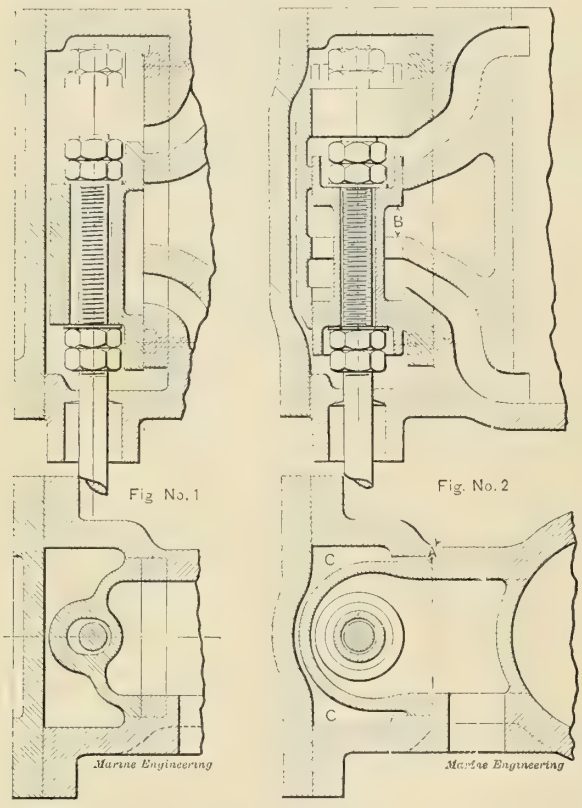
The Piston Valve Chamber.

I send you herewith several sketches of repair work, which, although it cannot be classed among the engineering repairs, is still of interest as a repair job.

Quite a number of auxiliary engines on board ship such as the centrifugal circulating pump engines, electric light engines, blower engines, windlass and steering engines, etc., are still fitted with slide valves. Since the advent of high steam pressures the slide valves are occasionally a great source of annoyance, owing to their excessive wear, the quantities of cylinder oil required to keep them in good condition and the resulting damage to the boilers and surface condensers from the oil, making it imperative to adopt the piston valve where possible. The advantages and disadvantages of the piston valve in comparison with a slide valve are too well known to be discussed, and in a seagoing auxiliary the slight difference in economy will be more than compensated for by the absence of cylinder oil lubrication and consequent lesser amount of care and attention required.

In most cases where an engine is still in good condition it is possible to substitute a plug piston valve

for a slide valve at small expense, as shown in sketches Fig. 1 and Fig. 2. The main difficulty is to get room for a piston valve of proper diameter, because the valve stem of a slide valve is so close to the valve face. This entails facing off the valve seat, either by hand or, better, by machine, and in either case care must be taken not to cut through the valve chest A, Fig. 2. Usually a false seat, as shown in Fig. 1, has already been installed, due to the excessive wear of slide valve and face, and in such a case it is only necessary to remove the false seat and put the piston valve chamber in its place. Unfortunately it is almost impossible to make this improvement such that the piston valve takes steam in the center, owing to the location of the receiver port and steam inlet on the valve chest, but as



the engine in question has no doubt been running for a considerable time with the high pressure steam on the valve stem packing, it is to be assumed that there is no difficulty at that point. In designing the chamber after the diameter of the valve has been determined, care must be taken that the passages C C, Fig. 2, at sides of chamber have a combined area of at least as much as that of the main steam pipe, so that there will be no wire drawing of steam on either the top or bottom of the valve. In most cases the valve chest cover must also be remodeled, as shown in Fig. 2, to make room for the piston valve chamber.

On placing the slide valve in its top and bottom position in the chest, as shown in Fig. 1, it is often the case that there is very little room left, consequently it is necessary to start out with the proposition that the nuts on the valve stem must retain their same relative position when the piston valve is installed. This entails making the piston valve of a shorter length than the slide valve, and reversing the ends for the nuts, leaving barely enough room to tighten them. A small special wrench will be of great assistance for this. Shortening the valve entails contracting the steam ports and bridges, but especially the exhaust port, and when the valve is at one end of its travel the exhaust opening B must be at least as wide as the steam port.

When putting the valve chamber in place, the piston valve must necessarily be inserted with it at the same time. If the seat in the chest has been faced up by machine, red lead putty makes a good joint, but if the seat has been faced up by hand it is well to make a joint of wire gauze and red lead putty. In either case it is difficult to bring the valve exactly central with the valve stem, and if the valve is made to fit snugly on the rod, the wear on the valve stem guide or any irregularity in the packing is apt to make the piston valve bear on one side of the chamber, with the consequent wear in the chamber due to the comparatively small size of the valve. It is better, therefore, to allow the stem to be free in the valve, and use washers top and bottom, the same as on the slide valve. Allow, say, one-eighth inch plug, and design the thickness of the shell of the valve so that there will be ample area around it for exhaust passage.

In fastening up the valve chamber a row of screws top and bottom will be sufficient, as it is stiff and not likely to spring. PISTON VALVE.

QUERIES AND ANSWERS.

Q.—How can I calculate the force with which the shaft of a motor turns? 2. Is there any rule for calculating the weight that a magnet will lift that is not too complicated? D. F. K.

A.—(1) The force with which a motor armature shaft turns, or the torque as it is called, can be found by multiplying the product of the volts and the amperes by seven and dividing by the revolutions per minute. This rule gives the turning moment or torque measured in feet and pounds, and is true to within a fraction of one per cent. To illustrate, suppose the motor takes a current of 100 amperes, and that the voltage is 80, then 100 x 80 x 7 is equal to 56,000, and if the speed is say 1,000 revolutions per minute, then the torque will be 56 pound-feet, since 56,000 ÷ 1,00 gives this quotient. This means that at one foot radius the turning force exerted will be 56 pounds.

(2) The lifting capacity of permanent magnets can only be found by actual trial, owing to the fact that there is a very great difference in the strength of such magnets, even when made identical in every particular. For electromagnets, the most simple rule for determining the lifting power is to multiply the number of square inches of pole area by 40, which gives the lifting power in pounds, providing the object lifted makes a perfect contact with the pole tips. To obtain this capacity the wire coil that energizes the magnet must contain 25 ampereturns for every inch of length of the magnet, counting in the distance from pole to pole. This length is to be measured along the center line of the magnet cores.

Q.—What is the surest method of calculating the amount of coal required for a voyage of any distance, say ship had quadruple engines? J. M.

A.—In order to compute the coal required for a given voyage the indicated horse power of the main engine must be known and then based on experience with similar engines the coal required per indicated horse power must be assumed. This will give the coal required per hour and then per day. To this must be added an allowance for the auxiliaries. Then if the speed is known the time will result, and thus the total amount of coal required. Thus for example, suppose that the engine is of 3,000 indicated horse power and that we may assume for the main engine one indicated horse power for 1 1-2 pounds of coal. This would give 4,500 pounds of coal per hour, or say 2 tons of 2,240 pounds. This would give 48 tons per day. To this we may add for auxiliaries and galley 1 1-2 tons, making a total estimated expense of 49 1-2 tons per day. Then suppose that with this power the mean speed expected is 12 knots and the distance 4,032 miles, the time required will then be 336 hours or 14 days, and the total coal 14 × 49 1-2 or 693 tons.

Turbine Steamer King Edward.

The *King Edward*, the latest of the Clyde passenger steamers, and fitted with Parson's steam turbines, made an average speed of 20.48 knots on several runs over the measured mile.

The principal dimensions are as follows:—

Length	250 ft., 0 in.
Beam	30 " 0 "
Depth moulded	10 " 6 "
Depth to promenade deck	17 " 9 "

The illustration representing the vessel under full steam, gives the general appearance of the vessel. She has fine lines and a good run aft. She is easily handled, and because of the low center of gravity of the machinery, ample stability is secured without a full bilge or long floor. Many experiments were made by her builders, Messrs. William Denny and Brothers, Dumbarton, on various forms of models in their experimental tank, and the result is a very fine and fast form. The sharp bow and easy delivery are made possible by the lightness of the engines.

STEAMER KING EDWARD, DRIVEN BY STEAM TURBINES.

The propelling machinery consists of three sets of Parson's steam turbines, each working on a separate shaft. Steam at 150 pounds boiler pressure enters the middle or high pressure turbine, where it expands five times and then passes to the two outer, or wing, low pressure turbines. It there expands twenty-five times, making a total ratio of expansion of 125, and exhausts into the condenser. For going astern, steam is admitted to small turbines placed inside the exhaust ends of the wing turbines. When going slow the middle turbine is not used and the steam passes direct to the wing motors. The movements of the steamer can be easily controlled by the use of throttle valves simply arranged. There is one screw on the central shaft and two on each of the other shafts. The main air pumps are driven by gearing from the wing shaft. Feed pumps, circulating pumps and forced draft system are worked by independent engines. The auxiliary air pump, for clearing the condensers when the main engines are not running, is operated by the engine of the circulating pump. The remaining auxiliary machinery is similar to that in other vessels. Steam is supplied by one double ended return tubular boiler placed in a closed stoke hole.

The total weight of machinery under running conditions, including turbines, condensers, steam piping, auxiliaries, shafting, propellers, etc., is 66 tons.

On the trial trip of June 26th, the before-mentioned speed of 20.48 knots was maintained. The steam pressure at the boilers was 150 pounds, vacuum 26 1-2 inches, air pressure in stoke hole 1 inch, mean revolutions 740, estimated indicated horse power 3,500. Figures of the coal consumption have not yet been published, but it is stated that they are low.

The advantages of this type of engine are many. The turbines are about one half as heavy per horse power of machinery as the ordinary type of engine. They take up very much less space and can be placed under the main deck. The engines run practically without noise and vibration. The only vibration felt on board was at the stern, and was doubtless due to the propellers.

The *King Edward* is now running on a daily passenger route down the Clyde. The above cut is reproduced from *Engineering*.

Mark Twain's "Donkey" Engine.

Editor of Marine Engineering:

After reading the account of the remarkable engine of "The Swallow," in the July issue of your paper, I have come to the conclusion that the drive way power must have been a "Donkey Engine."

San Francisco. Constant Reader.

Cruiser Columbia.—The high-speed United States Cruiser *Columbia* has been brought to the New York Navy Yard to replace the *Vermont* as a receiving ship.

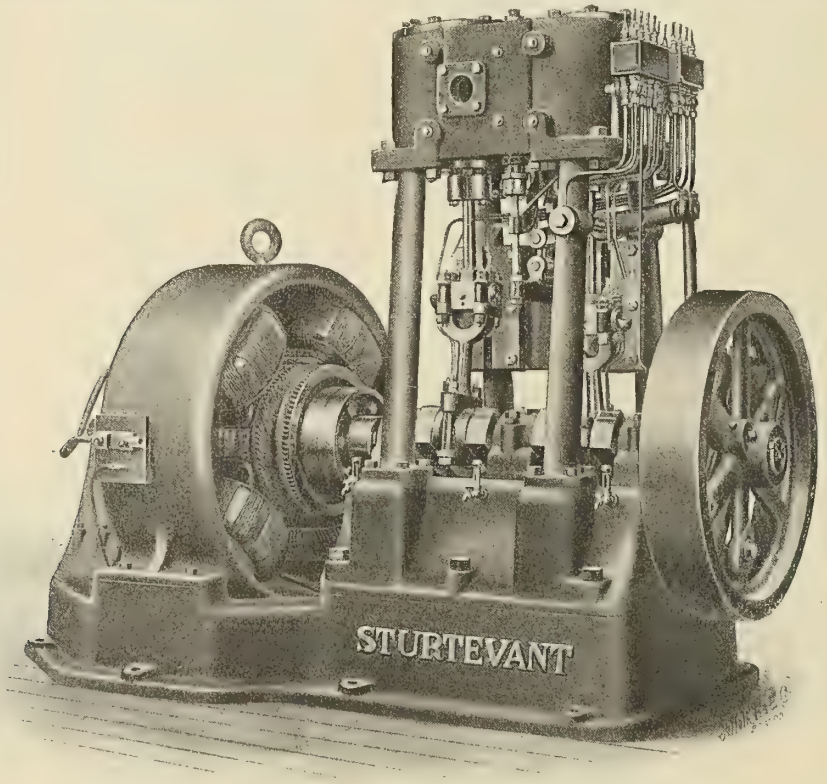
New San Francisco Dock.—A new masonry dry dock is being built at Hunter's Point. The dock is 750 feet long from the gate seat, with a width of 122 feet at the coping and 74 feet at bottom. At high tide there will be 30 feet of water over the sill.

ENGINEERING SPECIALTIES.

A Typical Sturtevant Generating Set.

During the past few years the B. F. Sturtevant Co., of Boston, Mass., has been making great strides in the development of its electrical department. Beginning as it did with the building of motors for direct connection to fans, it took some time to convince the public that this company was definitely in the field as builders of a special line of small high-grade generating sets. This work, however, is the natural outcome of the possession of a very extensive line of engines of over 100 sizes and under 250 horse power, and of a similarly extensive line of sizes of motors designed for direct connection to fans. In the accompanying illustration is presented one of their latest designs in a generating set, with open type vertical compound engine and four-pole generator. In this design the bed carries three main journal bearings, brass bushed in their lower halves and provided with continuous oiling devices in connection with oil reservoirs beneath; its interior is formed into a basin, which collects all drip from water or oil. The four heavy upright columns are securely fastened to this bed, and to their upper ends is bolted the single cylinder casting, comprising the two cylinders, which are of relatively large diameter and short stroke. The two piston valves are operated in unison by a single rocker and yoke, each regulating the admission of steam to one cylinder. The crossheads are of the slipper type, with projecting crosshead pins; the connecting rods have yoked crosshead pin ends and are of large size. Both connecting rods and crossheads are of forged steel, and all parts of the engine are of the highest grade as regards material and workmanship. The cylinders are thoroughly lagged. Complete sight-feed oiling arrangements are provided for all bearings. These engines are built in sizes 6 1-2 inch, 11 inch by 5 1-2 inch and 7 inch, 13 inch by 5-12 inch, with output at 150 pounds of 47.5 and 60 horse power.

The armature shaft is direct connected to the engine shaft and carries an armature of the barrel wound toothed drum type, with slotted discs of carefully annealed sheet steel, which, after being coated with an improved insulated varnish, is mounted upon a cast iron drum. This drum is provided with longitudinal air ducts, which connect in turn with radial ducts passing through the core, and by means of small blades or vanes inserted in these ducts compel the circulation of a constant current of air, thereby greatly facilitating ventilation and insuring an extremely cool running armature. The winding for all low voltage machines is of copper bars. High voltage or very slow speed machines have the armature wire wound with machine-formed coils, which coils are thoroughly insulated before being placed upon the core. The magnet frame is of special magnet steel, and has the field cores cast therewith. The ring is cast in one piece. The commutator consists of drop forged segments of pure copper, mounted upon and secured between cast iron flanges of spider construction which allow a circulation of air inside as well as outside and conduces to low temperature. Carbon brushes only are used in these machines, and mounted in holders of the sliding socket



STURTEVANT GENERATING SET.

type, with easy facilities for adjustment and removal. A full load run for a sufficient length of time to bring every part to its maximum temperature has never been found to produce a temperature rise exceeding 40 degrees centigrade.

Fireproof Bulkheads and Covering.

After the naval battles of Manila Bay and Santiago the Navy Department decided to dispense with wood wherever possible in the construction and furnishing of the vessels of the Navy. In these engagements it was demonstrated that fire on board ship is equally if not more destructive than the direct result of an enemy's shells. The H. W. Johns Manufacturing Company, of New York city, at once undertook experiments in making a non-splinterable and fire-proof material for bulkhead lining that would meet the requirement, and the form of construction which resulted was first fitted on the battleship *Indiana*. A frame work of light vertical and horizontal angles is built on the face of the bulkhead; this is covered with a galvanized wire cloth, and upon this is fastened a sheet of Asbestos Navy Brand Fire Felt, 1 1-2 inches thick. An outside covering of three-eighths inch Asbestos Prepared Panelling Board is then securely attached and trimmed with iron mouldings, and the whole is painted with a fire and water-proof paint and then decorated as may be desired. It is evident that this forms a light and effective lining. When laid upon the sides of the ship or upon the stiffener side of a bulkhead, the fire felt is placed between the frames or stiffeners flush with the tips of the angles, thus taking up but little space. This lining has also been used under the decks over boiler rooms, on boiler room casings, inside magazines, etc., when heat insulation is desirable.

In all, eleven government vessels, cruisers and battleships, have been fitted with this material, and orders have been placed for supplying it to the ships now building. On the *Illinois*, which is fitted throughout with this insulation, a marked reduction in temperature was noted on her trial trip. It is stated that the temperature of her boiler rooms reached 155 degrees, and yet, when all hatches were battened down, so complete was the insulation that the temperature in the compartment directly above did not exceed 100 degrees.

The manufacturers are also preparing for the market a thin fire-proof, non-splinterable panel board to take the place of screen bulkheads, and will be glad to furnish further information on this subject to those interested.

WARDROOM ON WARSHIP, WOODEN JOINING.
METHOD OF INSTALLING, FIREPROOF BULKHEADS.

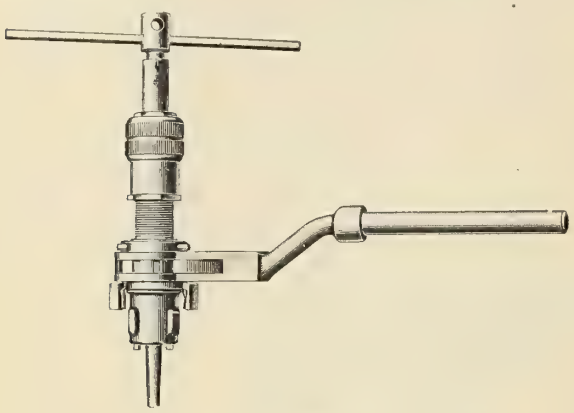
FINISHED WARDROOM, FIREPROOF BULKHEADS.
ANOTHER WARDROOM, FIREPROOF BULKHEADS.

Atlas Tube Expander.

Among the usual difficulties encountered in expanding tubes are the uneven joint between the tube and the head, the necessity of continued hammering upon the taper pin and the difficulty in forcing the rolls over lumpy welds. After much experiment the Atlas tube expander was made to overcome these and other defects. Instead of revolving the taper pin and feeding it by continued hammering upon the head, the entire roller case revolves with the ratchet lever. This increases the speed of the expander about three times, likewise reducing the time necessary to expand the tube. Applying the power to the case instead of the taper-pin also facilitates rolling imperfect interior tube surfaces, such as lumps of rough welds, etc., and eliminates the jerking motion when a lump is met. The taper pin is fed with a screw feed nut, thus avoiding all hammering upon the pin and prolonging the life of the tool to a great degree. The rollers are made with the proper taper to bring the surface of the roll parallel with the interior surface of the tube, insuring a good joint throughout the thickness of the head. At the bottom of the feed nut is a thin hexagon nut which acts as a depth gauge. This is advantageous where a number of tubes are to be expanded, for with this gauge nut the operator can feed the taper pin to the same depth for each tube, thus obtaining uniformity. This form of expander has a large range of adjustment, the scope

of the largest size, for example, being limited to 2 3-4 to 3 1-2-inch tubes. The operation of changing the adjustment to suit various sizes is very simple and takes but a minute.

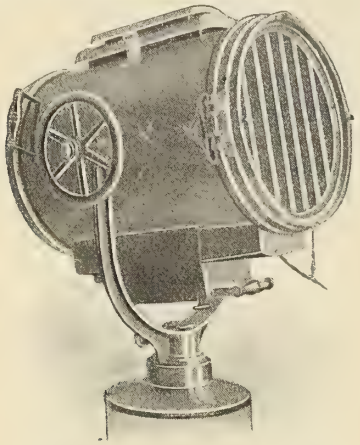
The ratchet type here illustrated is but one of several manufactured by the Watson-Stillman Co., of New York.



ATLAS TUBE EXPANDER.

The Bogue Marine Projectors.

The accompanying cut illustrates one of the improved type of marine projectors adapted for coasting and river steamers, ocean and towing tugs, wrecking steamers, pleasure yachts, etc. This apparatus, made in japanned iron or in polished brass, with copper doors and trimmings, is entirely weather-proof and is most substantial in construction. The mirrors used are of the Mangin type, conforming to the specifications of the United States naval authorities. The lamp is shunt wound with horizontal feed carbons, operat-



IMPROVED MARINE PROJECTOR.

ing automatically on any direct low potential circuit, and is perfectly steady when the voltage of dynamo is as low as 50. The lamp is also fitted with a simple attachment to feed by hand if occasion requires. The projector can be placed on top of the pilot house, and by means of a hollow shaft fixed to the standard with an inner rod engaging with gears, the necessary motions for throwing the beam in any desired direction are easily obtained, and the light is at all times under the control of the pilot. The numerous sales reported the past season in the United States, Canada and Great Britain give evidence of the high efficiency of this apparatus.

The manufacturer, Chas. J. Bogue, 217 Centre street, New York, has issued a complete catalogue covering projectors, search-lights, automatic and hand-feed focusing arc lamps, and other electric lamps for special purposes.

Examination for the Engineer Corps U. S. Revenue Cutter Service.

An opportunity will soon be offered for bright young marine engineers to obtain a life position in the Government service. The opportunity in question will be an examination for the position of Second Assistant Engineer in the United States Revenue Cutter Service. There are at present two vacancies, and those who do not obtain the highest averages, but pass satisfactorily, will be placed on an eligible list, and will be available for subsequent vacancies. It is hoped thus to obtain an available list of eight or ten men, in addition to filling the two vacancies. The examination will be strictly competitive, and is open to any American citizen who fulfils the following requirements:—

He must be not less than 21, nor more than 28, years of age, physically sound and well formed, and not less than 5 feet 3 inches in height.

He must have had not less than eighteen months' experience in a machine shop, or responsible charge of a steam engine for that length of time. In addition, he must also have had not less than six months' sea service on board of a seagoing vessel. If the applicant is a graduate of a technical institution, his four years training in this manner will be accepted in lieu of the shop experience, but the requirement of six months' sea service will be insisted upon.

The examination will be conducted by a board of officers, of which Engineer-in-Chief J. W. Collins, R. C. S., will be the president, and will be held in the city of Washington as soon as a sufficient number of applicants have presented themselves.

The pay of a Second Assistant Engineer on board ship is $1,308 per annum. Once admitted, the candidate is then in the line of promotion, which is made in strict accordance with seniority. A First Assistant Engineer receives $1,608 per annum, and a Chief Engineer, $1,908. If detailed on shore duty, engineer officers receive $25, $30 or $40 per month in addition to the above rates of pay, as commutation of quarters.

Vessels of the Revenue Cutter Service are stationed at the leading ports on the Atlantic, Pacific and Gulf coasts. There are also two vessels stationed on the Great Lakes, and every summer four or five cutters are detailed to patrol the waters of Alaska and the Behring Sea, cruising from Sitka to Point Barrow at the extreme north. One or two of these vessels make annual cruises to North Eastern Siberia.

Appointments in this service are similar in all respects to those in the Army and Navy, and its officers are liable to dismissal only for gross misconduct.

Full particulars of the approaching examination can be learned by addressing a communication, in the applicant's own handwriting, to the Secretary of the Treasury, Washington, D. C.

THE PROFESSOR ON SHIPBOARD.

Story of an Attempt to Combine Theory With Practice.

BY C. A. MC ALLISTER, FIRST ASSISTANT ENGINEER, R.C.S.

CHAPTER I.

The Professor was a man of small stature, slightly stoop shouldered, somewhat cadaverous, wore glasses, but withal carried a general air of intelligence and good nature. After graduating from college at the head of his class, he had been employed for several years as an engine draftsman at a large shipbuilding establishment, where he became very proficient in the theoretical side of marine engineering. A vacancy finally occurred in the chair of engineering in his college, and he was tendered the position. This he gladly accepted, as being more to his liking than the hustle and worry incident to a billet at a progressive shipyard.

Having now more leisure at his command he devoted considerable time to the preparation of essays to be read before engineering societies, and finally became the author of a treatise on his favorite branch, marine engineering. In this way his name became prominent in the profession, and he was looked upon as more or less of an authority by men interested in the business.

The Professor had an older brother, who was, in every particular, as different from his younger relative as two men can be. In his youth he was stout and robust, fond of all outdoor amusements, and very early in his career developed a fondness for the water. To him, going to school was looked upon as a sort of imprisonment, and his abhorrence for books was very pronounced. His father pleaded with and threatened him, but all to no avail. His mind was set on going to sea, and nothing else would do. Finally he was taken out of the public school, much to his delight, and yielding to his father's advice he started in as an apprentice in a large machine shop, with the ultimate intention of going to sea as an engineer.

Being naturally apt in learning anything in which he was interested, he rapidly picked up a good knowledge of the trade, and at the end of his apprenticeship was looked upon as a first-class machinist.

He soon found employment on a large coastwise steamship as a fireman. Being very attentive to his duties and a sober young man, it was not long before he was advanced to an oiler's position. A vacancy occurring by the death of an old chief engineer, and the young man having by this time sufficient experience, he obtained a license as third assistant, and was given that position on another of the company's steamers. After ten or twelve years of faithful service as a licensed engineer he was advanced until he became the chief engineer of one of the most modern vessels of the line.

He was very fond of his younger brother, the professor, but on such occasions as they met he could not refrain from poking fun at him, in a good natured way, on account of what he termed his "foolish booktalk." Many were the friendly arguments they held on various topics connected with marine machinery, each of course presenting his own side of the case. One of the chief's favorite taunts to his learned brother was that he would not know how to get a vessel's engine under way, even if he did know all about designing it. As a matter of fact this lack was the professor's weakest point. True he had made several voyages across the Atlantic on fast passenger ships, and had once been a guest on board a United States battleship during her official trial trip. Finally, at the urgent invitation of his sea-going brother, he decided to take a trip with him on his vessel, which was soon to sail for a South American port. The chief told him that he could spend as much time in the engine and fire rooms as he wished, and that, if he thought he could make any improvements he was welcome to make suggestions to the men.

The Professor, who was then on his annual vacation, decided to make the trip as instructive as possible, and being very thorough in everything he undertook, he made all necessary preparations to spend considerable time below the gratings. To his other clothing he added three suits of overalls and a cap, and on the morning of sailing day he came aboard the ship seemingly prepared for any emergency. He was, of course, welcomed by his brother, assigned to a pleasant stateroom on the upper deck, and introduced to the other officers.

The ship left New York promptly at the appointed time, and was soon steaming past Sandy Hook on her way to the southward. As the sea was smooth the Professor decided to begin his investigations on marine engineering afloat, and made up his mind to spend the first day or so in the fire room, thinking that the proper place to begin. He finally put in an appearance, clad in a suit of overalls, redolent with the smell of dye-stuffs, and fitting him like a bag on a beanpole. The Chief was not around at the time, so the book man slowly descended the slippery steps to the lower engine room and groped his way to the fire room, arriving there just as the 4 to 8 watch was coming on. The watch consisted of a water tender, four firemen and two coal passers, known technically as "snipes." They gazed with astonishment as the spare form of the Professor emerged into the fireroom, and nudged each other knowingly, while one brawny fireman, who had not recovered from the effects of the water front whiskey he had imbibed before sailing, shouted out derisively, "Git onto his goglets!"

This ejaculation created a laugh at the Professor's expense, which, however, was rapidly followed by silence as the hustling second assistant, who had charge of the watch, came into the fireroom and told all hands that the Professor was the Chief's brother, and that he must be respected accordingly. Being now assured that the men knew who he was, the college man proceeded to look about him with a critical eye. The first thing that attracted his attention was the act of a fireman who opened one of the furnace doors and proceeded leisurely to fill up the furnace to the very top with coal, after which he sat down, filled his pipe, and began smoking. This seemed to shock the Professor's ideas on combustion, so he explained to the man that it would be much better to carry his fires 8 or 10 inches deep, in order to secure more perfect combustion, and wound up his remarks by saying, "Always carry your fires parallel, and not too deep." This brought forth the inquiry, "What the divil does 'parel-eel' mean, Sor?" The Professor explained to him that they should be of the same depth for the whole length of the fur-

nace, and at the same time concluded to use no more mathematical or scientific terms around that fireroom. While he was on his subject he explained to the men that the practice of carrying "crown sheeters" was a very bad one. While no doubt it saved the firemen work by not being compelled to charge the furnaces at such frequent intervals, it filled the furnaces to such an extent as to prevent the proper mixture of air and gases, and consequently the boilers would not steam nearly so well as they would if light fires were carried and the slice bars used more frequently. At this point he noticed three of the firemen open the doors of different furnaces and begin charging them at the same time. After they were through he called their attention to this as being very bad practice, explaining that this rush of cold air into three different boilers at the same instant had a very bad effect on the production of steam, and told them that in the future they should arrange to fire each furnace separately, and to work very quickly, so as to keep the doors open as brief a time as possible.

A little later, noticing a large accumulation of ashes in one of the ash pans, he directed one of the coal passers to haul them out and put them in a pile in an out-of-the way place, at the same time explaining that if ashes were allowed to accumulate in that manner it hindered the free access of the air through the grate bars, thus preventing the fires from burning as they should, and at the same time incurring the danger of overheating the grate bars. While one of the furnace doors was open he had the opportunity of observing the spacing of the graet bars, and, much to his surprise, found that the air spaces were very much cramped. He made a mental note of this and determined to recommend that new bars be fitted with air spaces not less than 40 per cent of the total grate surface. He also saw at a glance that the bridge walls were too high, and prevented to a certain extent the free flow of the gases from the furnaces. This he determined could be remedied by putting in new bridge walls with their tops slightly crowned, and having a clear area between the crown of the furnace and top of bridge wall of about 16 per cent of the grate area.

While thus soliloquizing he was suddenly brought to a realization of his surroundings by a noise like a shot from a gun, and immediately thereafter he became deluged with a shower of scalding water. Not knowing what had broken loose and being completely terror-stricken, he made a dash for the door, falling over a coal scoop and landing on a pile of coal in his flight. These antics caused a roar of laughter among the men, and looking around he saw the water tender climbing up on the grating with his head and hands covered with old bagging. The cause of the commotion was the breaking of a gauge glass directly over where the Professor had been standing. The automatic valves in the pipes had failed to work promptly, but the stop valves were shut off quickly by the water tender, with whom such matters were of frequent occurrence.

The Professor had not learned of such incidents in his books, and he could not help admiring the readiness and bravery displayed by the water tender in climbing up on the grating in the terrific heat, and putting in a new glass almost before he himself had recovered from the shock the outbreak gave him. Being somewhat unnerved by his fright from the explosion, and smarting from the effects of the hot water, the Professor decided to postpone further investigation for that day. As he gazed in the mirror in his room and saw his smoke-begrimed features reeking with perspiration, he made up his mind that there was a decidedly unpleasant side to marine engineering, to which he had just had a slight introduction. He determined, however, to again visit the fireroom on the following day, but inwardly resolved to keep away from the vicinity of water gauge glasses. The Chief looked in on him for a few minutes, and was convulsed with laughter at the woe-begone appearance of his brother. The Professor's mental discomfort was not at all relieved by the remark, "Oh! you are getting off easy today. Wait until you stand a watch in a gale of wind!"

(To be continued.)

LAUNCHES.

Steamship Pathfinder.—On August 15th the steamship *Pathfinder*, built for Henry T. Knowlton and Amos D. Carver, of New York, was launched from the yard of Harlan and Hollingsworth Co. She measures 321 feet long, 44 feet 11 inches beam, 35 feet in depth.

El Siglo.—The Morgan Line steamship *El Siglo* was launched at Newport News on August 7th. Her dimensions are: Length over all, 406 feet; length between perpendiculars, 380 feet 8 1-2 inches; beam moulded, 48 feet; depth moulded to awning deck, 33 feet 9 inches; tonnage, 4,666 gross tons.

Ferry Boat Cape May,—The ferry boat *Cape May* to be run on the Delaware branch of the Philadelphia and Reading Railway Co., was launched from the yard of the Harlan and Hollingsworth Co., Wilmington, Del., recently. The *Cape May* is of the following dimensions. Length between perpendiculars, 126 feet; length over all, 169 feet; beam moulded, 30 feet.

Ferry Boat Chancellor. — The wooden ferry boat *Chancellor*, built for the New York and College Point service, and designed by H. J. Gielow, was launched from the yard of the Townsend and Downey Shipbuilding and Repair Co., Shooters Island, N. Y., on August 6th. The boat is 175 feet long, 37 feet beam, 60 feet 6 inches over guards and 16 feet deep.

Torpedo Boat Destroyers.— A triple launch took place at the Maryland Steel Company's yard on August 15th. The vessels launched were the torpedo boat destroyers *Truxton*, *Whipple* and *Worden*, officially known as Nos. 14, 15 and 16. Each is 248 feet on water line, 23 feet 3 inches extreme beam, and at a draft of 6 feet displaces 433 tons.

Battleship Maine.— The battleship *Maine* was launched from the yard of William H. Cramp and Son on July 27th. She is 393 feet 10 1-2 inches over all, 388 feet between perpendiculars, 72 feet 2 1-2 inches beam extreme, and at a mean draft of 23 feet 6 inches displaces 12,300 tons. Steam will be furnished at 256 pounds pressure by 24 Niclausse water tube boilers, with 54,109 square feet of heating surface. The two sets of triple expansion engines, with cylinders 38 1-2 59 and 92 inches in diameter by 42-inch stroke, are estimated to develop 16,000 indicated horse power.

THE EFFECT OF SHORT CIRCUITED FIELD COILS UPON THE OPERATION OF AN ELECTRIC GENERATOR.

BY WILLIAM BAXTER, JR.

The effect produced by short circuits in the field coils of generators upon their action is not the same with two pole and multipolar machines. In the first named type the effect is not noticeable unless a very large portion of the wire is cut out by the short circuit, say one-third or more. This statement, it must be understood, refers to the shunt coils only; if any considerable portion of the series coils is cut out there will be a decided drop in the voltage. The reason why cutting out a large portion of the shunt coils does not affect the action of the machine to a noticeable degree is that when the wire is cut out the resistance is reduced, in consequence of which fact the current strength is increased, so that although the number of turns of wire is reduced, the strength of current flowing through the remaining turns is increased; and the gain in one direction is very nearly equal to the loss in the other. To illustrate the point more fully, suppose that one-half the wire in the shunt coils is cut out by a short circuit, then the resistance will be reduced to one-half, so that the current will be doubled. If the remaining half of the wire made just as many turns around the coils as the half cut out, then the magnetizing force would not be changed in the least, for we would have half the number of turns with double the current flowing in each coil. The turns, however, are not all of the same length, those on the inner layer being shorter than any of the others, while those on the outer layer are the longest of all. From this fact it will be seen that if the wire cut out forms the outer layers, the half remaining in service will contain more than one-half the total number of turns, and as the current through it will be doubled, the total number of ampereturns will be more than with all the wire in service. Hence under this condition the voltage of the generator will be increased. For the same reason, if the wire cut out includes the inner layers, the number of turns in the remaining wire will be less than one-half, and as a result the ampereturns will be less than the total, and as a consequence the voltage will be reduced. From the foregoing it will be seen that in a two pole generator, the effect of a short circuit in the shunt field coils is not noticeable in so far as the action of the machine is concerned, unless a larger portion of the wire is rendered useless, and even then, if the coils are of large diameter and the wire is wound shallow, the difference between the length of the inner and the outer layers will be so small that the effect upon the voltage will be insignificant. If, however, a large portion of the coils is short circuited, the reduction in the resistance will be so great as to permit a current of such strength to pass through the wire as to heat it to a point where the insulation will be charred and the coil burned out.

In a multipolar generator, the effect of a short circuit in the shunt field coils is to cause the brushes to spark badly. The reason why this is the case can be made clear by the aid of the accompanying diagrams. These diagrams represent a four pole machine, this type being selected on account of its being the most simple. In the first diagram, Fig. 17, the broken lines *a a a a* indicate the paths of the magnetic flux developed by the magnetizing coils, which are not shown, but which in most designs are placed around the poles *P P N N*. If the four coils are perfect, each one will have the same magnetizing force, and as a result, the magnetic flux developed by each one will be the same. Hence the lines *a* will be similarly located with respect to the four poles. Now to make the effect of short circuits clear, let us suppose that the coil on the right side pole is all cut out, then the paths of the magnetic fluxes will be changed in the way illustrated in Fig. 18, in which it will be seen that part of the magnetism from the left side pole passes by the *P* poles and runs to the right side, thus converting this into a *P* pole. The coils wound upon the two *P* poles will tend to prevent the passage of the magnetic flux along the paths *b b*, and may actually stop it off entirely if the

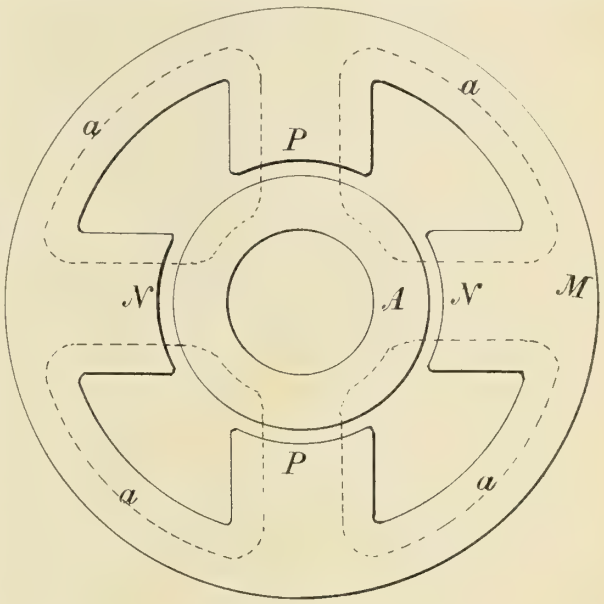


FIG. 17.

magnetizing coils are large and the magnet cores small, but if the right side pole is not changed to the *P* polarity, it will be rendered so weak an *N* pole as to be practically of little value. If only a portion of the shunt coil on the right side pole is cut out by the short circuit, then the polarity will not be reversed, but the strength of the pole will not be as great as that of the opposite one.

In Fig. 19 the lines drawn from the poles to the armature indicate the magnetic force or flux which acts upon the wire wound on the armature, and develops electromotive forces therein. When the current flowing in the armature wires is very small, the action of the magnetism of the field is not disturbed, and in such a case each pole will act upon one-quarter of the armature surface, and this quarter will be directly opposite the pole. To state the case more clearly, if the armature current is zero or nearly so, each pole will act upon a quarter of the armature surface located between the lines *c c* and *d d*, the center of the poles and the centers of the quadrants being in line with each other. As soon as a current of any magnitude begins

to flow in the armature it will develop magnetic fluxes, which will tend to produce poles ahead of the field poles and in line with the diameters *c c* and *d d*. The result of this action of the armature currents, which is called armature reaction, is to force the regular field magnetism ahead of its natural position. In producing this shifting of the field magnetism the poles are rendered weaker at the rear end and stronger at the front end, as is indicated by drawing the flux lines closer together on the *b* sides of the poles, and more spread out on the *a* sides. This shifting of the magnetic fluxes of the poles to an advanced position shifts the quarters of the armature which are acted upon by the several poles so that the bounding diameters become *e e* and *f f*, instead of *c c* and *d d*. The stronger the armature current becomes the greater its reaction, and as a result the further the lines *e e* and *f f* are advanced. It will be noticed, however, that the magnetic flux of all the poles is advanced a like amount, so that each one still acts upon one-quarter of the armature wire.

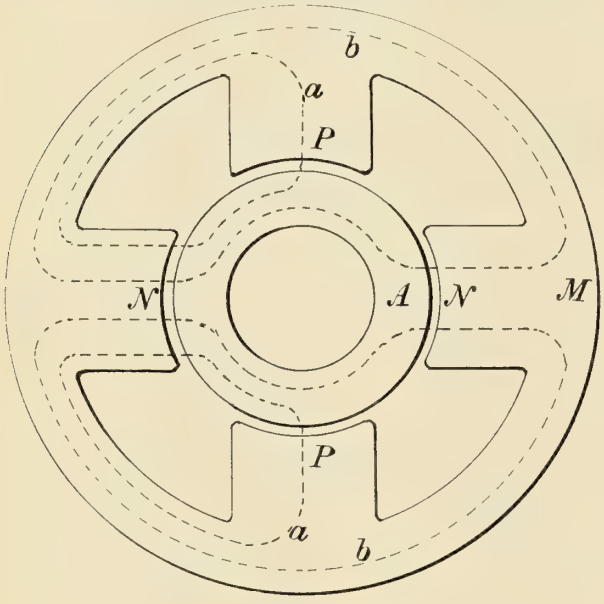


FIG. 18.

The effect of this advancing of the magnetism by the action of the armature current is seen practically in the behavior of the brushes, which must be advanced as the current increases to obtain sparkless running. If the armature has a great many turns of wire wound upon it and the field is relatively weak, the magnetism will be advanced so much with a strong current as to render it necessary to continually readjust the brushes as the load varies, so as to keep down the sparking. If the armature has a comparatively small amount of wire upon it the reaction will be greatly reduced, and can, in actual practice, be so small that if the brushes are adjusted so as to run well with a medium load, they will run very nearly as well with full load or no load. Well designed generators are made with a small amount of wire on the armature, and will run with any load from zero to full capacity without changing the brushes.

Although the action of the armature current is to advance the magnetism, the advance is symmetrical all the way around the circle, and if the brushes are held one-quarter of the circumference apart, they can be placed in a position where they will not spark, for this position is slightly in advance of the lines *e e* and *f f*. This symmetrical advance occurs, however, only when the field coils are all of the same strength. If one of the coils is defective in consequence of a short circuit, its magnetizing action will be reduced, and then the conditions will be such as are illustrated in Fig. 20. In this diagram the right side *N* pole is supposed to be weakened by a short circuit in the coil wound upon it. As a result of this weakening the portion of the armature acted upon by the pole is reduced to less than one-quarter, while the arc covered by the left side pole is more than one-quarter. For the same reason the top and bottom poles will also act upon more than one-quarter of the circle. In other words, the weakening of the right side pole causes the other three to act on more than their proper share of the armature surface as well as to reduce the surface that the defective pole covers.

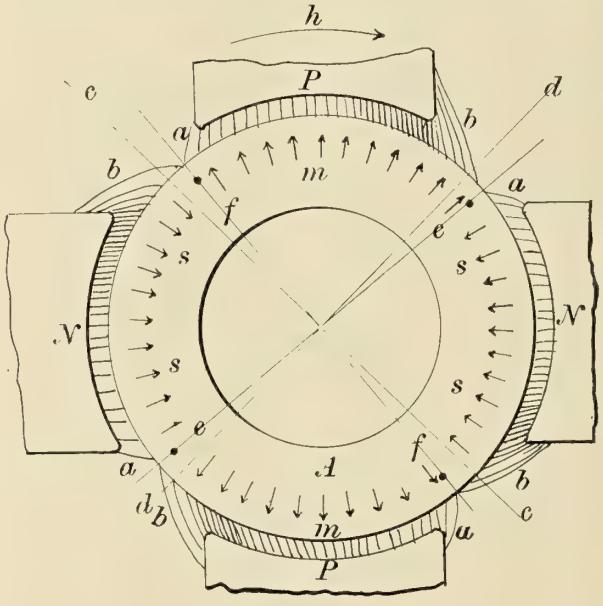


FIG. 19.

In the above case, as in Fig. 19, the field magnetism will be advanced by the armature reaction, so that if the armature current is very small the bounding lines of the fluxes from the four poles may be *c c* and *d d*, while with a strong armature current they will be shifted ahead to the position of lines *e e* and *f f*.

As will be noticed in the diagram, the four lines that separate the four pole fluxes are not one-quarter of the circumference apart, and therefore if the brushes are held equidistant it will not be possible to set them so as to secure sparkless running. We may find a position in which one of the brushes will not spark, but then all the others will. If the brushes are so arranged as to be independently adjusted, then we can set them one at a time so as to finally reach the sparkless position, which will be with the four brushes slightly in advance of the lines *e e* and *f f*. This position, however, will only produce sparkless running for one strength

of current, for with changes in the armature current the amount by which the lines *e e* and *f* and *f* are advanced ahead of *c c* and *d d* will not be uniform. The lines inclosing the left side pole will be advanced more than any of the others, and those inclosing the right side pole will be advanced the least. Thus it is seen that the arc of the circle encompassed by each pole flux will change as the armature current changes, so that even if the brushes can be adjusted independently no position can be found in which they will run well with varying loads.

When the shunt field coils of a generator become short circuited, if they are not burned out so as to render the machine inoperative, then if the brushes cannot be made to run without sparking, the pole on the opposite side of the armature may be weakened so as

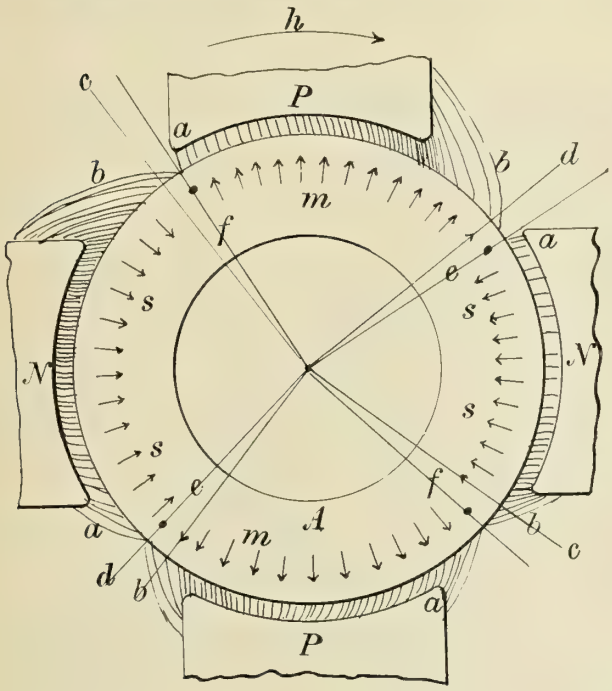


FIG. 20.

to balance the defective one. In the case of compound wound generators this expedient can be improved upon. For example, take the case illustrated in Fig. 20, in which a shunt coil is short circuited wholly or in part. Now if we were to cut out an equal amount of wire in the left side coil, the result would be that the total resistance would be so far reduced that the current flowing through the shunt coils might be strong enough to destroy the insulation. In addition to this danger we should have the fact that the top and bottom poles would be stronger than the side ones. This difference in a four pole machine would be very small even if all the wire were removed from both the side poles, but in a six or eight pole machine it would make a decided difference in the relative strengths of the poles, and hence, in all but four pole machines, it is necessary to keep the magnetizing force on all the poles as nearly equal as possible. In view of this fact, if a shunt coil on one pole is short circuited, instead of equalizing an opposite pole by cutting out an equal amount of its shunt coil, it is better to increase the number of turns in the series coil wound upon the defective pole so as to bring it up to the same strength as the other ones, or nearly so.

The way in which defective field coils are found was explained in a previous article,* but we may here add that if it is found difficult to adjust the brushes so that they will all run with the same degree of sparking when the tension on all is the same and all other conditions are alike, then unless the brushes are unequally spaced it can be inferred that some of the field coils are impaired, and they should be tested, that is, if the sparking becomes so serious as to endanger the safety of the machine. It must be remembered that excessive sparking can in time develop short circuits between commutator segments, and thus short circuit the armature and cause a burn out.

Shipbuilding Returns.—The Bureau of Navigation of the Treasury Department reports 112 vessels of 16,120 gross tons built in the United States and officially numbered during the month of July, 1901.

State Naval Militia.—The annual summer cruise of the State Naval Militia organizations on Government war ships were abandoned this summer, owing to the lack of State support.

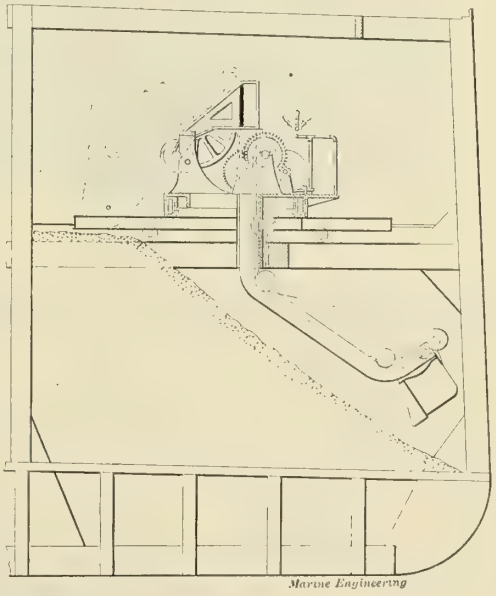
New Detroit and Buffalo Steamer.—Two new passenger steamers of 3,400 tons displacement are being built for the Detroit & Buffalo Steamboat Co., to run on a day line between the two cities.

Shipbuilding on the Great Lakes.—Reports received from shipyards on the Lakes state that much new work is under consideration, and many contracts are being closed.

SELECTED MARINE PATENTS.

677,600. ACETYLENE GENERATOR FOR LIFE-SAVING APPARATUS. JOHANNES RUCK, OLDENFELD, GERMANY.

677,610. UNLOADING APPARATUS. RICHARD THREW, LORAIN, OHIO.



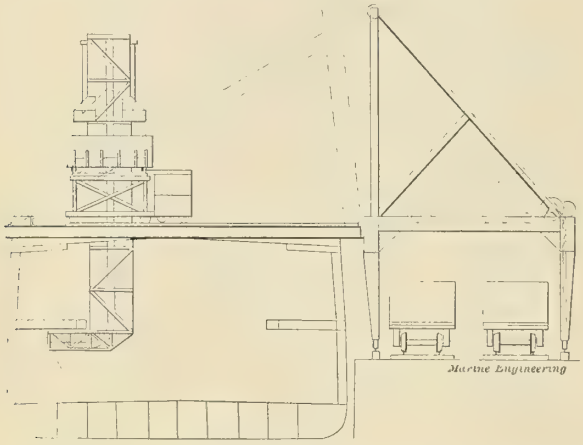
* See Marine Engineering for June, 1901, p. 256.

CLAIMS.—In an unloading apparatus, a car with necessary operating mechanism for guiding, raising and lowering a bucket.

677,619. ANCHOR. FREDERICK BALDT, SR., CHESTER, PA.

677,637. ADJUSTABLE SWINGING MANHOLE-PLATE. MICHAEL E. CASEY, MANSFIELD, OHIO.

677,718. UNLOADING APPARATUS. GEORGE E. TITCOMB, CLEVELAND, OHIO.

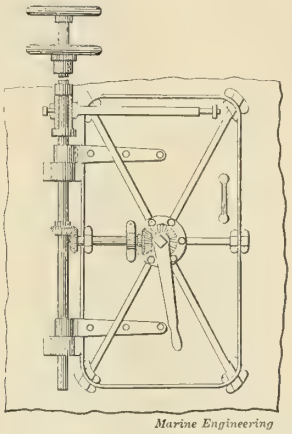


CLAIMS.—In an unloading apparatus the combination of a vertically adjusted member capable of extending down into the hold of a boat, and having its lower end extended laterally, continuous bucket-guides carried by said member, and means of rotating said member on vertical axis.

667,760. LIFE-BOAT. BENVENUTO GIANESE, GENOA, ITALY.

667,839. ANCHOR. JOHN N. YOUNG, ALAMEDA, CAL.

677,868. SHIP'S DOOR. JOHN A. KESSLER, PHILADELPHIA, PA.



CLAIMS.—In combination with a ship's door, a central disk adapted to be rotated by bevel gears from above or at the door; bolts pivoted to said disk and operated by turning the latter.

678,131. ALARM APPARATUS FOR INDICATING LOW LEVER OF WATER IN BOILERS. PETER N. GAMMELGAARD, CAPPELN, GERMANY.

678,193. PROPELLING MECHANISM FOR VESSELS. MARTIN A. PETERSON, SIOUX CITY, IOWA.

CLAIMS.—In connection with a vessel having longitudinal boxes with slotted bottoms, of rock-shafts journaled in said bottoms feathering paddles adjustably attached to the rock-shafts, and means for oscillating said rock-shafts.

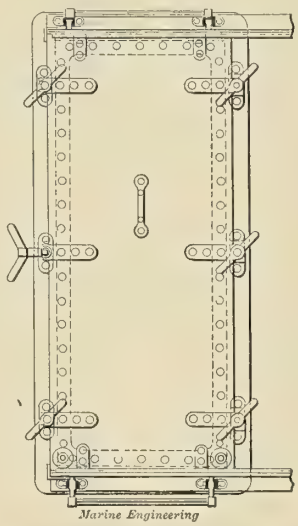
678,228. PROPELLER GOVERNOR. FRANK S. CONVIER, MONCTON, CANADA.

CLAIMS.—A governor for a propeller shaft comprising a brake-shoe for engaging with shaft, actuated by a cylinder piston, and controlled by a float.

678,297. LIFE-RAFT. JOHN V. JANIN, SEATTLE, WASH.

CLAIMS.—A life-raft with inflatable body portion, cork in pockets on opposite side, and pumps for inflating said body.

678,407. BULKHEAD DOOR. HAROLD LEE, EAST ORANGE, N. J.



CLAIMS.—In a closure for watertight bulkheads, the combination of a bulkhead having a seat, a door having packing rings, means for bringing the seat and packing rings in contact after the door has slid in position opposite opening, and lugs to engage door.

678,757. APPARATUS FOR AUTOMATICALLY FIRING SHIP'S GUNS. LUDWIG OBRY, TRIESTE, AUSTRIA-HUNGARY.

678,787. MARINE FIRE-INDICATING SYSTEM. FREDERICK W. MEYER, JERSEY CITY, N. J.

CLAIMS.—In a marine fire-indicating system, a station from which tubes run to the various holds and compartments of a ship and means for periodically drawing air through said tubes.

678,811. STEAM-TURBINE. THOMAS J. OBENCHAIN, LOUISVILLE, KY.

678,938. PROPULSION MECHANISM FOR BOATS. FRANZ BURGER AND HENRY M. WILLIAMS, FORT WAYNE, IND.

678,980. LUBRICATOR. DUGALD H. ROBERTS, DETROIT, MICH.

679,099. STEAM-DISTRIBUTING VALVE FOR MULTIPLE EXPANSION ENGINES. ROBERT L. WEIGHTON, NEWCASTLE-UPON-TYNE, ENGLAND.

679,149. LUBRICATOR. CARL A. HIRTH, STUTTGART, GERMANY.

679,246. LUBRICATOR. JOHN J. TUNNEY, PITTSBURG, PA.

679,358. STEAM-TURBINE. JOHN F. BRADY, CHICAGO, ILL.

679,502. LIFE PRESERVER. GEORGE GRAHAM, PORT ARTHUR, TEXAS.

CLAIMS.—In a life preserver the combination of two flaps to fit the front and back of the human body, air pockets in said flaps with tubes for inflating same and straps for adjusting the said flaps to the body.

679,632. AMMUNITION HOIST. ROBERT MATHEWS, MANCHESTER, ENGLAND.